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ROENTGEN-RAY EXAMINATION WITH THE MILLER-ABBOTT TUBE[1]

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INTRODUCTION

DEFLATION of the gastro-intestinal tract by means of a stomach tube was first suggested, in 1884, by Kussmaul and Cahn (1) as an aid in the management of cases of ileus. For the same purpose Westerman (2) and McIver *et al.* (3) used the duodenal tube. The technic of duodenal deflation was greatly improved by Wangensteen (4), who introduced the use of continuous suction-syphonage apparatus with the duodenal tube. The result was a diminution in the mortality of acute ileus (Wangensteen and Paine (5), 1933).

A series of experiments in small intestinal physiology, in Miller's clinic, requiring intubation resulted in the development, by Abbott, of a double-lumen tube for this purpose, now known as the "Miller-Abbott tube" (Miller and Abbott (6), 1934). The smaller of the two lumens connects with a small perforated metal tip about which is attached a small rubber balloon; through this lumen the balloon can be inflated and deflated by injecting or withdrawing air. Near the end of the larger lumen are three or four holes through which gas and fluid may be aspirated or fluid material injected. Abbott showed that proper inflation of the balloon was necessary, after it had passed into the duodenum, to enable peristalsis to move the tube caudad in the intestine. Abbott and Johnston (7) applied this tube to the treatment, localization, and diagnosis of obstructing lesions of the intestinal tract.

The technic of insertion of the tube, as used at the Presbyterian Hospital, has been described in detail by Leigh, Nelson, and Swenson (8). It seems unnecessary to discuss it further here except to remark that a little experience is necessary and that the beginner should not become discouraged during his first attempts.

The use of the Miller-Abbott tube in the treatment of both mechanical and paralytic ileus, at the Presbyterian Hospital, has been followed by a striking diminution in the mortality of these conditions. The results in 76 cases have been reported by Leigh, Nelson, and Swenson (9). Suffice it to say here that the mortality for the whole series of 76, including the cases with peritonitis and gangrene of the intestine, was approximately 16 per cent. This includes seven of the early cases in which an unsuccessful attempt to pass the tube was made. In the 69 cases in which the tube passed into the small intestine, the mor-

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tality was 5.9 per cent. The mortality in 38 cases of mechanical ileus in which the tube was used, was reduced to 7 per cent. In 50 cases of uncomplicated mechanical and paralytic ileus, there has been one death, a mortality of 2 per cent.

The purpose of this communication is to discuss the part played by roentgen methods of examination in the Miller-Abbott tube procedure.

ROENTGEN-RAY EXAMINATION

In process of passing the tube into the duodenum, fluoroscopic aid may be neces-

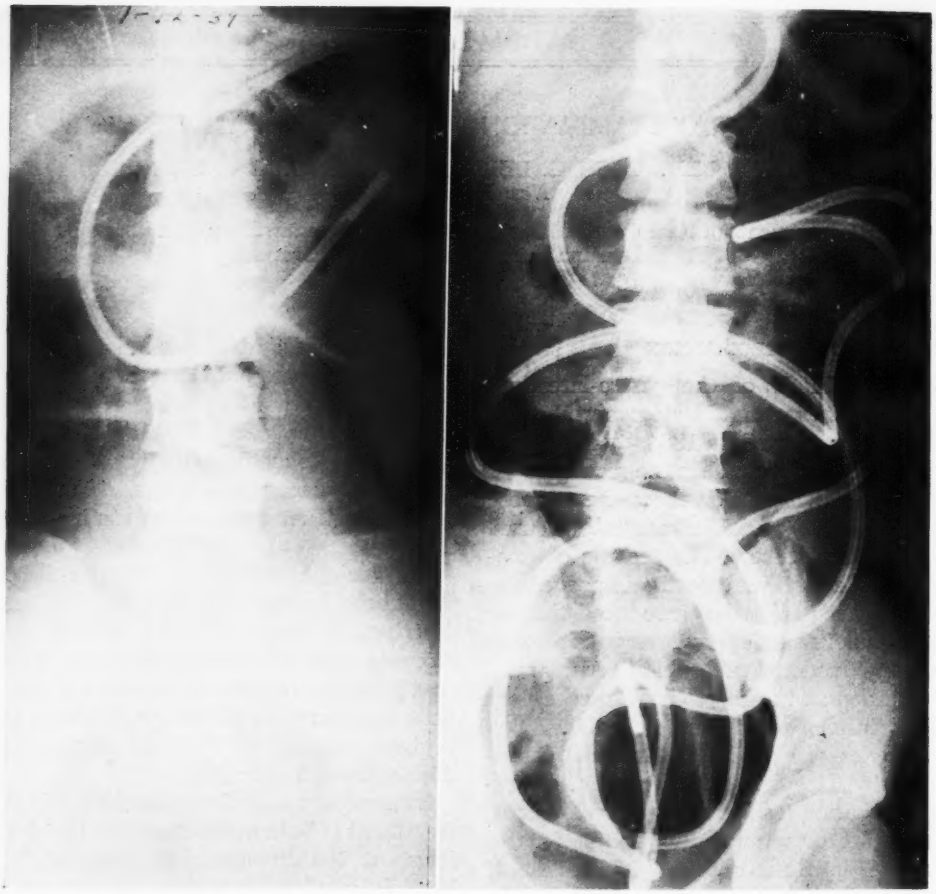

Fig. 1-*A*. Fig. 1-*B*.

Fig. 1. Case 1. Mechanical ileus due to post-operative adhesions. *A*, A supine film shows gas-distended loops of small intestine. The tip of the Miller-Abbott tube with the balloon inflated is at the duodenojejunal junction. *B*, Three days after insertion the tube tip is arrested in the lower ileum. Dilated loops of small intestine can no longer be seen, indicating satisfactory deflation.

Case 1. J. M. (Unit No. 569,465). A 20-year-old man was admitted with acute appendicitis. At operation the appendix was removed, and an inflammatory reaction was noted in the wall of the ileum where it had rested against the acutely inflamed appendix. On the second post-operative day, abdominal distention began, unrelieved by the usual treatment. On the fourth post-operative day he had cramping abdominal pain, nausea, and vomiting. Films of the abdomen showed gas-distended loops of small intestine with fluid levels. The

(*Case history continued on bottom of next page.*)

sary, but as experience is gained it needs to be used less and less frequently. However, it is important to be sure that the tube is not coiled up or turned back on itself in the stomach; it should lie along the greater curvature with the tip in the antrum pointing toward the pylorus.

After the tube has entered the duodenum and the process of deflation has begun, roentgen-ray examination becomes of prime importance; its part in the procedure may be summarized as follows:

1. To determine the progress of the tube.
   (*a*) The tip may progress continuously to the cecum.
   (*b*) The tip may be arrested by an obstruction.

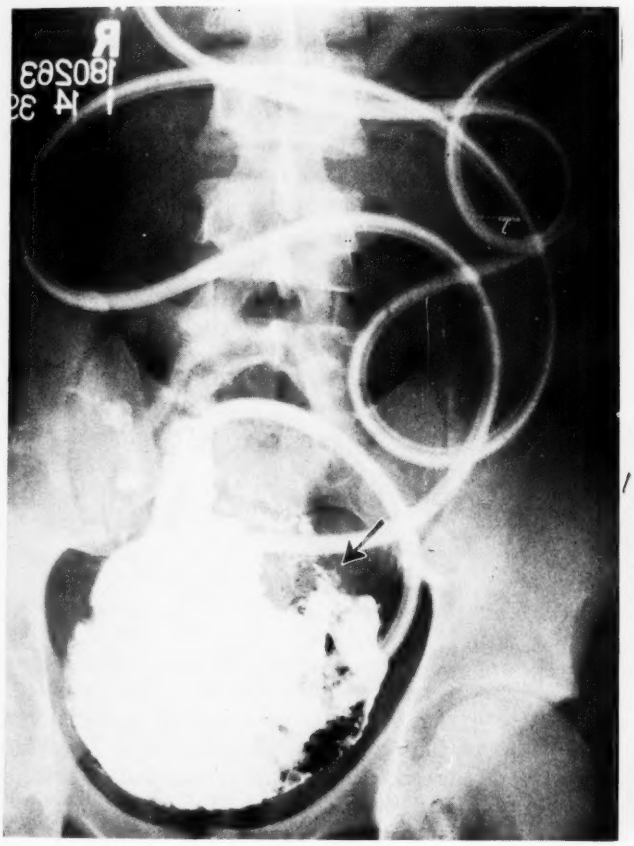

Fig. 1-*C*.

Fig. 1-*D*.

Fig. 1. Case 1. Mechanical ileus due to post-operative adhesions. *C*, Following the injection of barium through the Miller-Abbott tube, the obstructed point is obscured by overlying barium shadows on the straight anteroposterior film. *D*, With the overlapping loops pushed aside by the pressure cone, the constriction, in which are normal mucosal folds, can be clearly seen. This illustrates the importance of pressure films in such cases.

Miller-Abbott tube was inserted and in three days was arrested in the right lower quadrant. Injected barium suspension disclosed a constriction in the terminal ileum, which was demonstrated again two days later. At operation the ileum, about 20 cm. from the cecum, was angulated and bound to the posterior pelvic wall. No other adhesions were present. The intestine was released. Two days later the tube was removed and recovery was uneventful.

Fig. 2. Case 2. Paralytic ileus, post-operative. The tube passed downward so slowly that at one time it appeared to be arrested. To make sure no obstruction was present, barium was injected which disclosed no evidence of a constriction. A contraction is taking place below the tube tip. The film was made with a spot film device on the fluoroscopic table immediately after the injection.

Case 2. F. B. (Unit No. 528,402). A 32-year-old nurse was admitted to the hospital after one day of cramping abdominal pain with no bowel movement or flatus. She had had a similar attack two years previously which disappeared spontaneously. Nine years previously she had had an appendectomy. Roentgen examination of the abdomen disclosed gas-distended small intestinal loops with fluid levels. At operation the loops of lower ileum were found matted together by adhesions. About two feet proximal to the ileocecal valve were two points of obstruction past which it was impossible to force gas by pressure. Resection of this loop was done. She continued to have pain and on the fourth day after operation the Miller-Abbott tube was inserted. The intestine was deflated, with improvement. Suction was discontinued. Distention and vomiting recurred and the tube was vomited out the next day. It was re-inserted but passed down very slowly. Barium suspension was injected, disclosing no obstruction. Deflation was satisfactory and recovery was uneventful.

2. To determine the efficacy of deflation.
   (*a*) Satisfactory deflation.
   (*b*) Undeflated loop of small intestine suggesting volvulus.
   (*c*) Gas-distended large intestine with deflated small intestine suggesting an obstruction of the large intestine with either mechanical or paralytic ileus of the small intestine.
3. Injection of barium sulphate suspension through the tube.
   (*a*) To determine the exact location of the tube tip in the intestinal tract.
   (*b*) To determine the nature of the obstruction.
      1. Kink, usually short, with normal mucosal pattern in uncomplicated mechanical ileus.
      2. Narrowing, usually elongated, with abnormal mucosal pattern.
         (*a*) Strangulation.
         (*b*) Inflammation involving intestinal wall.
         (*c*) Malignant neoplasm.
         (*d*) Intussusception.

Technic.—To follow the progress of the tube and to determine the efficacy of deflation or the recurrence of ileus after discontinuing suction, flat films of the abdomen are needed (Figs. 1-*A* and 1-*B*). While it is desirable to take them on the Potter-Bucky diaphragm table, films taken with the bedside machine will suffice if it seems inadvisable to transport the patient.

The injection of barium sulphate suspension (as suggested by Abbott and Johnston, 7) should be made, if at all possible, on the fluoroscopic table. It is highly desirable to be able to take films on the fluoroscopic table as the barium flows on and outlines the important loops of intestine. Spot films, both with and without pressure, are often quite helpful, as it is frequently

necessary to rotate the patient or to push a superimposed loop aside in order to bring a kink or a narrowed area into profile (Fig. 1-*C* and 1-*D*).

Progress of the Tube.—In paralytic ileus as deflation progresses the tube advances slowly, much more slowly than in mechanical ileus. It may take as long as from five to seven days for the tip to reach the cecum. During the process, the patient's condition usually improves steadily. In such cases a film of the abdomen once a day usually suffices.

In uncommon instances the tube advances so slowly that the question of an obstruction may be raised. Then barium

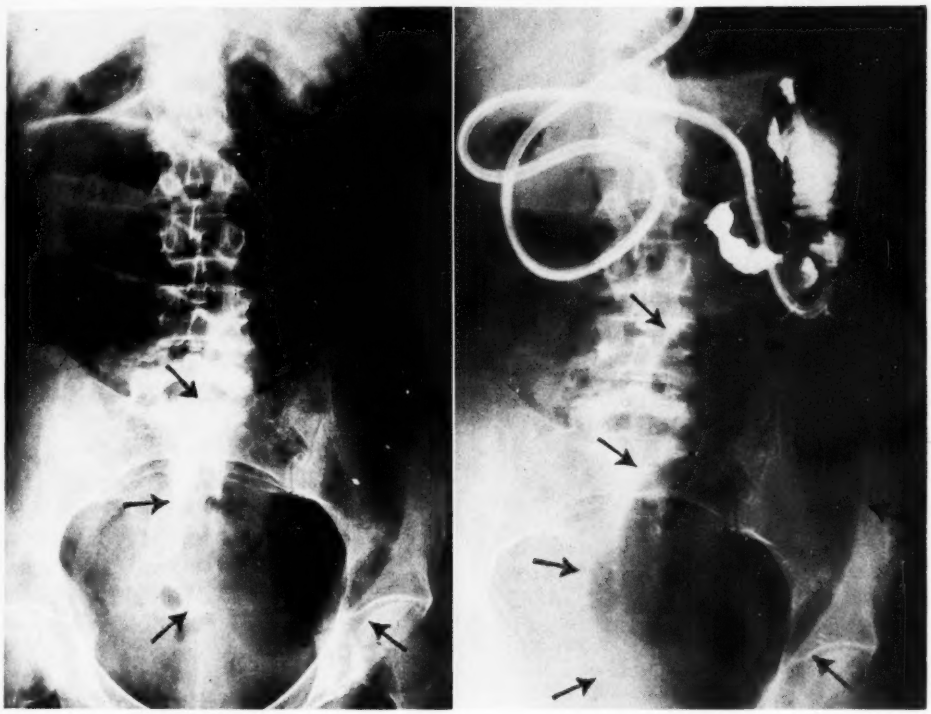

Fig. 3-*A*. Fig. 3-*B*.

Fig. 3. Case 3. Mechanical ileus due to volvulus. *A*, Gas-distended loops of small intestine are present in the upper abdomen. In the left lower quadrant is a large oval gas shadow (arrows) which did not change with deflation. *B*, The Miller-Abbott tube tip lies in the upper jejunum. The gas-distended loops of small intestine are diminished in number and size, indicating that deflation is progressing. The large gas shadow in the left lower quadrant (arrows) is unchanged in size, suggesting a loop with obstruction at its proximal and distal ends.

Case 3. M. M. (Unit No. 525,413). A 60-year-old woman was admitted because of abdominal distention, nausea, and vomiting of three days' duration, her first attack. Three years previously she had had an hysterectomy. Roentgenograms of the abdomen disclosed dilated loops of small intestine with a large gas-distended loop lying in the lower part of the abdomen to the left of the mid-line. A Miller-Abbott tube was passed into the upper jejunum. After twelve hours of suction, the distended loops of small intestine in the upper abdomen were markedly diminished in size but the large shadow in the lower abdomen was unchanged, suggesting a "double-ended" obstruction, possibly volvulus. At operation, a large, abnormally mobile cecum was twisted to the left with the terminal ileum. The volvulus was untwisted, the cecum was anchored in the right lower quadrant, and recovery was uneventful.

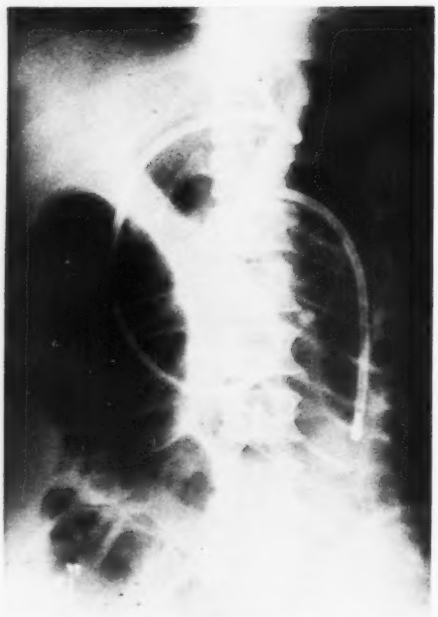

Fig. 4. Case 4. Paralytic ileus with obstruction of the large intestine, diverticulitis. With the Miller-Abbott tube in the jejunum, the small intestine was deflated while the large intestine remained distended, suggesting colonic obstruction with ileus of the small intestine.

Case 4. H. H. (Unit No. 552,089). A 51-year-old man two months before admission had had lower abdominal cramps which disappeared with four days' rest in bed. Two days before admission the cramping pain recurred with abdominal distention, a chill, fever, and loss of appetite. His doctor made a diagnosis of diverticulitis. Barium enema disclosed diverticulitis of the sigmoid without obstruction. He improved for six days. On the seventh day the temperature rose and signs of intestinal obstruction appeared. On the ninth day the Miller-Abbott tube was passed but did not go beyond the jejunum. Barium injection showed no obstruction. The small intestine was satisfactorily deflated but the large intestine became increasingly distended, suggesting obstruction of the sigmoid. Cecostomy was done; pus was found in the peritoneal cavity. The Miller-Abbott tube was removed. Seven days later he developed pneumonia and ileus. The Miller-Abbott tube could not be re-inserted. He died on the twenty-first day. At necropsy a perforated diverticulum of the sigmoid was found, with multiple peritoneal abscesses.

sulphate suspension may be injected which will show no evidence of constriction of the lumen ahead of the tube tip (Fig. 2).

In one case, which turned out to be an acute enteritis, the tube tip appeared at the anus in 12 hours with the 6.5-foot mark visible at the nose.

Failure of the tube to advance is indicated by the fact that no more of it is drawn into the nose, by regurgitation of the tube out of the nose if more of it is pushed down, and by the unchanged length of the tube shadow in the intestine on consecutive films. These observations suggest arrest by an obstruction and should be followed by the injection of barium sulphate suspension.

Progress of Deflation.—After the tube has entered the duodenum, continuous suction–deflation is begun. This results in a gradual diminution in the width of the distended loops visible on films of the abdomen and, as the tube advances, in a diminution in the number of gas-distended loops (Figs. 1-*A* and 1-*B*).

In one case (Figs. 3-*A* and 3-*B*), the distended intestine in the upper part of the abdomen diminished in size, but one large loop in the lower abdomen remained unchanged. This observation led to a suggestion that a double-ended obstruction, possibly a volvulus, might be present. At operation a volvulus was found consisting of an unusually mobile cecum and lower ileum twisted over to the left.

Deflation of the small intestine does not remove gas from the large intestine. Even when the tip of the tube is in the cecum the large intestine cannot be deflated, probably because of the thick character of the cecal contents. A cecostomy is necessary to deflate the large intestine. Consequently, satisfactory deflation of the small intestine may take place while the gas-distended colon remains unchanged (Fig. 4). If the tube tip passes to the cecum, mechanical obstruction of the small intestine is ruled out, showing that the ileus is paralytic in type. If the tube tip is arrested before it reaches the cecum, the possibility of an obstruction involving both the small and

the large intestine must be considered. In either case a barium enema is obviously indicated.

Injection of Barium Sulphate Suspension through the Tube.—The administration of barium sulphate suspension by mouth in the presence of undeflated ileus is useless because (1) the opaque material becomes so diluted by the fluid in the intestine that the contrast is not what it should be, and (2) the dilated, decompensated intestine pushes the material along so slowly, if at all, that it is impossible to outline the obstruction satisfactorily. However, in our experience, no deleterious effect has ever been observed following the ingestion or the injection of barium sulphate in diseases of the *small intestine*. This opinion is in apparent disagreement with Lofstrom and Noer (10). A certain amount of the injected opaque material is removed as the routine suction is resumed immediately after the examination, but no effort has been made to withdraw it for fear of ill effects on the patient. The barium suspension is not dehydrated in the small intestine and does not form firm masses as in the large intestine. (Barium sulphate should not be given by mouth in the presence of an obstruction of the large intestine.)

Barium sulphate stirred up in water, as well as commercial preparations, have been used as contrast media in these cases.

As deflation progresses, the compensation of the paralyzed intestinal wall is restored and its ability to contract returns. The opaque material then injected is *invariably* passed through the narrowed segment ahead of the tube tip. Experience in this connection indicates that no obstruction is "complete" in the strict sense of the word. The failure of intestinal contents to pass is based on decompensation and paralysis of the intestinal wall with consequent inability to push fluid through a constricted segment. The clinical terms "complete" and "incomplete" obstruction actually mean that decompensation of the intestinal musculature has or has not occurred.

The quantity of barium suspension injected should be small. It takes about 10 c.c. to fill the tube, and an additional amount of from 10 to 20 c.c. usually suffices. Too much opaque material may result in the obscuring of one loop by another.

It seems worth repeating that the injection should be made on the fluoroscopic table, preferably with a rapid switch-over spot film device. The balloon must be deflated to permit the barium to pass caudad. If the filled loop seems to be inactive, the balloon may be alternately inflated and deflated to stimulate peristalsis. The pa-

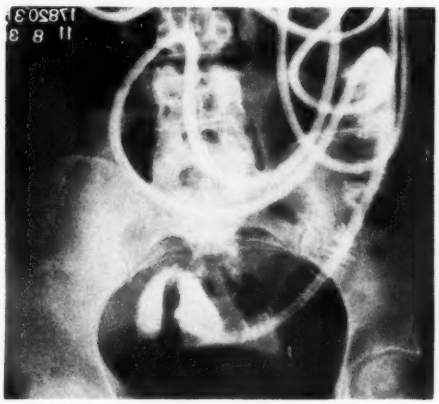

Fig. 5. Case 5. Mechanical ileus due to late post-operative adhesions. After deflation and arrest of tube, barium injection disclosed a short kink, without the aid of pressure apparatus (*cf.* Figs. 1-*C* and 1-*D*). The mucosal folds in the kink are normal.

Case 5. J. W. (Unit No. 433,379). A 47-year-old woman was admitted because of cramping abdominal pains, with distention, nausea, and vomiting of four days' duration. For two years, following the repair of a post-operative hernia, she had had similar attacks which had subsided spontaneously. Roentgen films of the abdomen showed evidence of ileus. A Miller-Abbott tube was passed into the duodenum and deflation was complete after two days of continuous suction. The tube was arrested in the lower ileum. Barium suspension was injected which disclosed a short angulation in the lower ileum. The adhesion causing this kink and those below it were divided at operation. On the fourth day after operation, the tube was removed and recovery was uneventful.

tient may mention cramping sensations when this is done. With deflation of the balloon, the opaque material usually passes down around or beyond the tube tip. Reinflation of the balloon tends to push the barium suspension ahead. In the great majority of cases it becomes immediately apparent whether or not a constriction is present. In paralytic ileus the barium passes slowly on to the cecum. If an obstruction is present, it may be necessary to rotate the patient or to apply pressure to

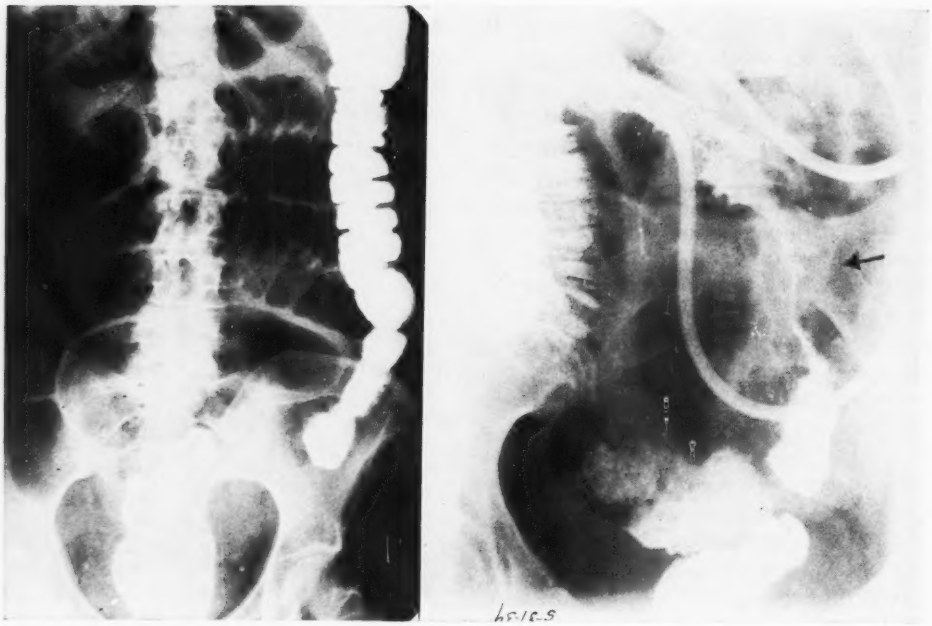

Fig. 6-*A* Fig. 6-*B*.

Fig. 6. Case 6. Mechanical ileus with strangulation. *A*, Because of suspected diverticulitis, a barium enema was done which showed no evidence of diverticula or inflammation. The middle portion of the sigmoid did not happen to be filled on this film and the distortion due to adhesions cannot be seen. Gas-distended loops of small intestine are clearly shown. *B*, After deflation and arrest of the Miller-Abbott tube in the ileum, barium was injected, disclosing a long narrow loop with low, flat mucosal folds suggesting some organic change in the wall, which proved to be strangulation.

Case 6. M. R. (Unit No. 313,032). A 59-year-old woman was admitted to the hospital because of a sudden attack of acute cramping pain in the lower abdomen, with vomiting of about 12 hours' duration. She had had a supravaginal hysterectomy 14 years previously and a long history of indigestion. Pain continued between cramping attacks. She had a slight fever. A tender mass was felt beneath the lower abdominal scar. Roentgen examination of the abdomen disclosed gas-distended loops of small intestine with fluid levels. The possibility of diverticulitis of the sigmoid was suspected. A barium enema was requested which showed the sigmoid to be distorted by adhesions but no diverticula or evidence of inflammation was demonstrated. On the second day after admission the Miller-Abbott tube was inserted, deflation progressed satisfactorily but pain continued. On the second day after intubation the tube was arrested in the ileum. Barium suspension was injected which showed an elongated narrowing of the ileum with coarse, flattened mucosal folds suggesting disease of the wall. At operation a loop of small intestine was caught beneath a shelf of adhesions. It was deeply congested but upon release its color improved and it was thought to be viable. The tube was left in place to take care of post-operative distention. Convalescence was complicated only by a stitch abscess.

displace an overlapping loop to bring the narrowing into profile. A spot film device is very helpful and sometimes absolutely necessary to get a film of the constriction as the barium flows through; such films are necessary for detailed study of the nature of the constriction.

The Exact Localization of the Tube Tip.—It is usually possible to tell by the position of the tube tip whether or not it has entered the large intestine. It is possible, however, that the metal tip might be in a loop of ileum which overlies the gas-filled cecum. This occurred in one case; after the injection of barium suspension the mucosal pattern of the loop containing the tube showed immediately that it was in the ileum and not the cecum.

Simple Obstruction without Inflammation.—An adhesion causing obstruction usually produces a narrow kink in the intestine (Fig. 1-*D*, Fig. 5), measuring from 1 to 1.5 cm. in length, in which the mucosal folds appear normal. The lumen of the gut distal to the obstruction may be quite small and must not be considered as part of the obstruction.

Elongated Narrowing Associated with an Abnormal Mucosal Pattern.—(*a*) Strangulation, by producing congestion and edema of the wall, causes flattening, widening, or even obliteration of the mucosal folds. With present experience it seems unlikely that the effect of strangulation and of inflammation could be differentiated with certainty on the film. The narrowing shown in Figures 6-*A* and 6-*B* was interpreted by one of us (R. G.) as probable inflammation but it proved to be strangulation.

(*b*) Inflammation involving the wall of the intestine from an adjacent abscess or other focus causes partial obliteration (Fig. 7) or coarsening of the mucosal folds in the narrowed area. Chronic sclerosing enteritis (regional ileitis, etc.) may cause mechanical ileus and may produce narrowing of shorter or longer segments of intestine. A short narrow segment might be indistinguishable from a constricting neoplasm because in both instances the mucous membrane may be destroyed.

(*c*) Malignant neoplasm invades and destroys the mucous membrane, and hence distorts or obliterates the mucosal folds (Fig. 8). An annular growth is usually relatively short—from 3 to 6 cm. Although

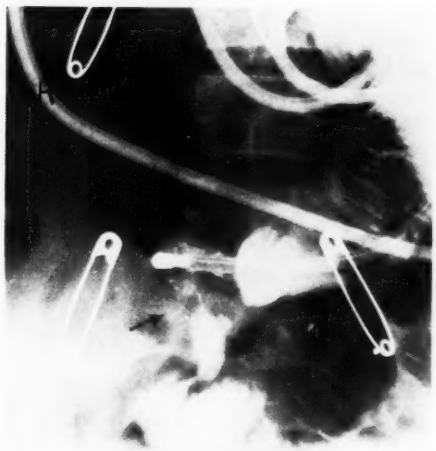

Fig. 7. Case 7. Mechanical ileus with peritonitis. After deflation and arrest of the tube, barium was injected disclosing a kinked, elongated, narrowed segment in which no normal mucosal folds can be seen.

Case 7. N. R. (Unit No. 570,936). A 13-year-old girl was admitted with acute appendicitis. At operation perforation of the appendix and localized peritonitis were found. Appendectomy with drainage was done. Post-operative distention increased and she had fecal vomiting when the Miller-Abbott tube was inserted two days after operation. Deflation was accomplished in 48 hours. On the fourth post-operative day, barium suspension was injected which disclosed narrowing of the terminal ileum with absent mucosal folds suggesting congestion and edema of the mucous membrane. This was thought to be due to post-operative adhesions with localized inflammation at the site of the right lower quadrant abscess. Suction was continued. Fluids and food were given by mouth. On the twelfth post-operative day she had a normal stool and suction was discontinued. On the sixteenth post-operative day the tube was removed and recovery was uneventful.

the mucous membrane has been destroyed, the inner surface may be irregular (Figs. 9-*A* and 9-*B*). Little at the present time can be determined as to the exact type of neoplasm from the appearance of the constriction; that is, as to whether it is carcinoma, carcinoid, or lymphosarcoma.

(*d*) Intussusception produces a long, narrow barium shadow. When the opaque material gets beyond the narrowing, it outlines the sheath into which the narrowed portion has invaginated, and the appearance will be the same as in any intussusception (Fig. 10).

COMMENT

It must be emphasized that the function of the tube is to deflate the distended loops and to restore the muscular efficiency of the intestinal wall. During this process, the patient rapidly becomes comfortable and is able to take food, which keeps the serum protein and electrolyte concentration normal.

In some cases of mechanical ileus, especially in those recently operated upon, the adhesion may be sufficiently soft so that, once functional efficiency of the intestine has been restored, the adhesion ceases to be of importance. It is well to make a test by discontinuing suction for from 24 to 48 hours before withdrawing the tube. If the patient gets along satisfactorily, the tube may then be withdrawn. If decompensation of the intestine recurs and the patient "blows up" again, suction can be re-

Fig. 8. Case 8. Mechanical ileus due to carcinoma of ovary invading the ileum. After deflation and arrest of the tube, barium was injected disclosing a moderate kink in the ileum. The pressure films show evidence of an impression on the outer side (arrow), suggesting an impression from without, with distortion of the mucosal folds on that side. On the opposite side the mucosal folds are normal. These changes were thought suggestive of neoplasm in the wall of the ileum.

Case 8. M. R. (Unit No. 550,184). An emaciated 65-year-old woman was admitted because of recurring attacks of abdominal distention and fever of over 16 months' duration, which were increasing in severity. The normal appendix had been removed without relief. The usual clinical and roentgen signs of ileus were present. The Miller-Abbott tube was passed and deflation completed in five days. The tube tip was then located in the lower ileum. Barium suspension, injected through the tube, disclosed a defect on one side of a loop of ileum with distortion of the mucosal pattern on that side interpreted as suggesting neoplasm. At operation a carcinoma of the right ovary was found, which was adherent to and apparently invading the wall of the terminal ileum, with widespread peritoneal metastases. Ileocolostomy to the transverse colon was done. Ten months later the patient was symptom-free and 20 pounds heavier.

sumed and operative procedures decided upon at the optimum time. If the tube is withdrawn too soon, it may be very difficult to re-insert it after the recurrence of ileus.

It is of great importance to get all possible information about the obstruction. Strangulation or gangrene of the intestine is suggested by (1) persistent fever and leukocytosis, (2) persistence of pain between attacks of cramps, and (3) a tender, palpable mass. In the presence of a strong suspicion of strangulation, operation is indicated without waiting for deflation but the tube should be left in place to aid in the management of post-operative distention. The demonstration of an abnormal mucosal pattern is an indication that something more serious than an uncomplicated mechanical ileus is present, although in some cases a positive differential diagnosis may not be possible with our present knowledge.

In some cases peritoneal adhesions cause abdominal pain without producing mechanical ileus. An ordinary barium study of the small intestine may show no evidence of delay or obstruction, or of a kink

Fig. 9-*A*. Fig. 9-*B*.

Fig. 9. Case 9. Lymphosarcoma of the jejunum. *A*, At one and one-half hours after the ingestion of barium, a short, narrowed segment of jejunum (arrow) without mucosal folds but with wavy margins was demonstrated. This was confirmed on other films and by injecting barium through the Miller-Abbott tube after arrest at this point. *B*, The resected specimen shows the growth to be invading the lumen. The inner surface of the growth is irregular, explaining the wavy margins of the barium shadow.

Case 9. W. D. (Unit No. 576,668). A 54-year-old man had attacks of abdominal cramps, nausea, vomiting, and diarrhea for ten months. Five months before admission a "strawberry" gall bladder and his appendix were removed without relief. A roentgen-ray study of the small intestine disclosed a narrow segment in the lower jejunum in which the mucosal folds were destroyed. The Miller-Abbott tube was inserted and was arrested at this site. At operation a lymphosarcoma of the lower jejunum with enlarged mesenteric lymph nodes was found. The tube was removed after two days and recovery was uneventful. He received radiotherapy and six months later appeared perfectly well.

which might be recognized as of clinical importance. With the balloon inflated, however, the Miller-Abbott tube may be arrested at a kink not otherwise demonstrable with certainty. After localization in this way the tube is left in place and the surgeon, at operation, is guided directly to the offending kink by the tube tip.

Fig. 10. Case 10. Mechanical ileus due to intussusception (lymphosarcoma of the ileum). The intussusception, ileum into cecum, was disclosed by barium injected through the Miller-Abbott tube after deflation and confirmed by immediate barium enema. The cause is not apparent and was found on pathologic examination to be lymphosarcoma of the ileum.

Case 10. J. O'H. (Unit No. 545,242). A 13-year-old boy was admitted because of cramping right lower quadrant pain, abdominal distention, and blood in the stools of three weeks' duration. The Miller-Abbott tube was inserted, the small intestine was deflated, and the tube was arrested in the lower ileum. Barium suspension injected through the tube showed intussusception of ileum into cecum. At operation the intussusception could not be reduced and resection was done. Pathologic examination showed that the intussusception was due to a lymphosarcoma of the ileum. The patient was given radiotherapy but died six months later of generalized lymphosarcomatosis.

In one case, gastro-intestinal examination, including a small intestine study, failed to disclose a cause for a persistently positive test for occult blood in the stools. The Miller-Abbott tube was passed and a specimen of intestinal contents was removed and tested for blood at each successive foot as the tip advanced in the small intestine. Finally a positive test was obtained. The tube passed on down to the terminal ileum where it was arrested by a clinically unimportant kink resulting from an old adhesion. Injection of barium disclosed nothing abnormal. At operation a carcinoma of the lower jejunum was resected. Re-examination of the films failed to disclose anything suggestive of malignant disease, probably because the involved loop was not filled with barium at the moment when any of the succession of films was taken.

CONCLUSIONS

The development of the Miller-Abbott tube and its use in deflation of the small intestine has proved to be an achievement of major importance in the treatment of mechanical and paralytic ileus. Roentgenograms of the abdomen during the procedure give valuable information (1) concerning the movement of the tube, (2) concerning the progress of deflation, and (3), after the injection of a barium suspension, concerning the localization and the nature of the obstruction.

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ROENTGENOLOGIC FINDINGS IN ACUTE OBSTRUCTION OF THE COLON

WITH PARTICULAR REFERENCE TO ACUTE VOLVULUS OF THE SIGMOID[1]

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THE active interest, in recent years, in the problem of obstruction of the small bowel, aroused by newly discovered methods of therapy and diagnosis, has served to obscure the importance of acute obstructions of the large bowel. Yet this condition presents a serious problem to the clinician, usually requiring emergency measures. It differs from a similar lesion at higher levels in the intestinal tract both in symptomatology and in treatment. Obstruction of the large bowel is not relieved to any degree by suction, so that temporization is usually unwise. For this reason it becomes necessary to make an accurate diagnosis at the earliest possible moment. Whether the obstruction be due to carcinoma, diverticulitis, benign stricture, volvulus, or to congenital anomalies, it is important for the surgeon to have as much information as possible concerning the nature of the pathologic process, the degree and position of the obstruction, and the possible etiologic factors. Toward achieving this end, the roentgen examination is of the utmost importance.

The use of barium sulphate in suspected obstruction of the large bowel does not involve as many objectionable features as in obstructions of the small intestine. Because the contrast medium can be given by enema, thus filling the bowel distal to the point of obstruction, there is no serious danger in such an examination, particularly if it is undertaken with circumspection. Frequently, however, the barium enema examination is of little value, certainly far less than in lesions of the colon without acute obstruction. The serious condition of the patient, often accompanied by a total inability to retain the enema, makes the procedure extremely difficult. Furthermore, the distended overlapping loops of gas-filled bowel militate against accurate interpretation. There is also the undesirability of passing any large quantities of barium beyond the site of the lesion and the danger of overdistending a bowel which may already be necrotic to further inhibit the examiner's efforts. With these difficulties in mind, films of the abdomen, preferably in a variety of positions, without contrast media are first made. An anteroposterior roentgenogram is made with the patient supine. If possible, a postero-anterior view should be obtained with the patient upright. If this is impossible, a postero-anterior view in the lateral decubitus position, preferably with the patient lying on the left side, is highly desirable. If the findings suggest colonic obstruction and it seems necessary to make a more certain diagnosis both as to the nature of the obstructive process and its exact position, a barium enema may be given. In a great many instances the latter is neither necessary nor desirable.

The simple roentgenogram of the abdomen should furnish a large amount of information toward answering the pertinent questions which come up in any acute abdominal condition in which acute obstruction of the colon is suspected.

1. Is there an obstruction of the intestinal canal of any type?

2. Is it a mechanical obstruction or simply a paralytic ileus?

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3. If obstruction is present, is it in the small or large bowel?
4. Where is the obstruction located?
5. What is the lesion which is producing the obstruction?
6. What is the size of the distended loops, especially the cecum?
7. Has perforation supervened?

It is unnecessary here to dilate upon the roentgen findings in acute intestinal obstruction as these have been dealt with adequately in numerous publications during the past decade. Just as in the case of the small bowel, acute obstruction of the large bowel may be simulated by other acute abdominal conditions. Hence it is necessary first to establish the presence of some type of ileus, which is readily demonstrated by the presence of distended loops of bowel. If upright or lateral decubitus films are made, fluid levels can usually be seen in almost any type of real ileus but especially so in obstructions of the colon. It is extremely rare that acute obstruction of the colon will produce symptoms necessitating immediate therapy without producing in the roentgenogram a readily visible, marked distention of the bowel loops.

The presence of gas in the colon without other findings is obviously not diagnostic, as this occurs under normal conditions. But the accompanying distention of the large bowel together with the evidence of fluid levels is of more specific significance. In a large series of cases of acute colonic obstruction, we have found that the difference between the gas-and-fluid-filled distended loops of the obstructed bowel and the gas found in the normal colon is of such striking character that there is rarely any difficulty of differentiation. A typical

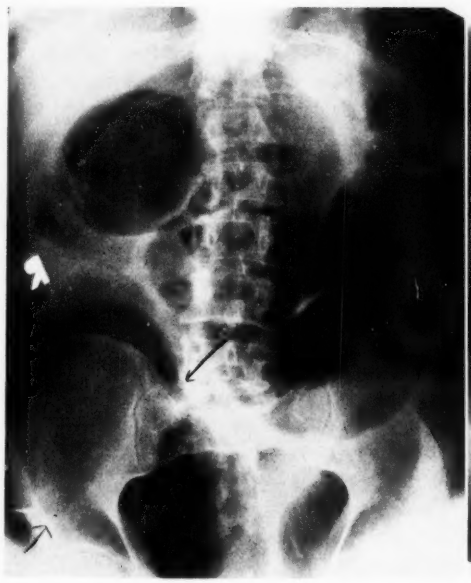

Fig. 1.

Fig. 2.

Fig. 1. Roentgenogram of abdomen, supine position, in case of carcinoma of the sigmoid flexure with acute obstruction of the colon. Note the gas-filled, markedly distended colon. The haustral markings are largely lost. The gas seems to extend deep in the pelvis because of the distention of the descending colon. Note the extreme dilatation of the cecum (arrows) signifying imminent perforation. There is no gas in the small bowel.

Fig. 2. Roentgenogram of abdomen, supine position, in case of adynamic ileus of the colon, simulating acute mechanical obstruction. Note uniform distribution of gas from cecum to rectum with very little gas in the small intestine. Distinction from actual obstruction low down could only be suspected from the column of gas extending into the rectum without evidence of an obstructive lesion on rectal examination. (Compare with Figure 1.)

illustration is shown in Figure 1, a case of carcinoma of the sigmoid flexure. The diameter of the colon is far beyond the normal; the haustral markings are widely separated; the colon extends far above its normal position.

The answer to the second question is far more difficult. The distinction, by roentgen findings, between a mechanical obstruction of any portion of the intestine and an adynamic ileus is often impossible. In the case of obstruction of the colon, less difficulty may be met with, but in occasional cases error will inevitably supervene. It should be noted at once that most cases of obstruction of the colon are of the closed loop type; that is, the ileocecal valve remains competent, hence there is little or no distention of the small intestine. If only the loops of large bowel are dilated, the ordinary types of adynamic ileus such as occur with peritonitis, pancreatitis, and from numerous other causes may at once be excluded. Furthermore, if only a portion of the colon is distended by gas and a point can be found beyond which the column of gas is absent or greatly diminished in diameter, the possibility of a paralytic ileus is very unlikely. There are, however, rare cases of adynamic ileus, confined to the colon, which simulate a mechanical obstruction. A case of this type is illustrated in Figure 2. This patient had all the clinical evidences of acute obstruction of the colon. On roentgen examination the distended loops are clearly made out, several times their normal diameter. Her condition was so acute that it was deemed inadvisable to do a barium enema examination and the signs of acute obstruction were so compelling that immediate colostomy was done. The patient succumbed. At autopsy, no mechanical obstruction whatever was found. None of the laboratory or autopsy findings cast any light on the origin of this colonic ileus as no lesion of the nervous system could be discovered. There was a history of pneumonia about two weeks preceding the attack of acute obstruction, but no other apparent etiology. In retrospect, on careful examination of the film, it becomes evident that the colon is distended well down into the pelvis, probably right up to the anal orifice. If this interpretation had been made prior to operation, the absence of evidences of an obstructive lesion on rectal examination might have led to the correct conclusion. This is the only means of differentiation from a true obstruction. It should be noted, however, that it is not always possible to conclude as to the exact portion of the bowel which is distended. Commonly, the enlargement of the descending colon may carry it into the pelvis, simulating a distended sigmoid or rectum. We have observed one other case of a similar nature in which no lesion of the nervous system or other cause of ileus was found.

Obviously, as is the case in obstructions of the bowel at any point, the final diagnosis is dependent upon a correlation of the history, physical findings, and laboratory data, with the roentgen observations. The signs found in scout films of the abdomen have none of the specificity of the ordinary type of roentgen examination of the gastro-intestinal tract with contrast medium. Nevertheless, careful study of the roentgenograms adds immeasurably to the possibilities of accurate and early diagnosis.

The determination of whether the obstruction is in the small or large bowel can usually be made without difficulty if the obstruction is in the colon. Dilated loops of colon do not usually simulate small bowel. The reverse is, no doubt, true, but in such cases in which distended small bowel loops simulate colonic loops, there are almost always other distended loops which can be recognized by their position, the character of their mucous membrane markings, and their size as being small bowel. Thus in cases of small intestinal obstruction, the diagnosis of adynamic ileus is occasionally made because it is thought that loops of distended large bowel are also present. In the case of large bowel obstruction, it is rare that some of the distended coils are not easily recognizable as large bowel. This at once

serves to eliminate a mechanical obstruction of the small bowel. If there are also present distended loops of small bowel, it is improbable that there is a mechanical obstruction of the colon.

As stated above, it is unusual for the accumulated gas in the colon to regurgitate into the small bowel, the ileocecal valve apparently remaining competent under such conditions. This is, unfortunately, not true in all cases. If distended loops of small bowel are found, they may be due to a number of factors in addition to incompetency of the valve. Lesions of the cecum itself may occasionally cause regurgitation into the small bowel. Such obstructions as intussusception of the cecum, not infrequently an accompaniment of tumors in this region, will obviously produce small bowel distention, as the latter becomes obstructed by this complication. Likewise, pressure on the small bowel, of sufficient degree to produce stasis, may be exercised by a tumor of the colon which is simultaneously producing an acute obstruction in the colon itself (Fig. 3). Frequently the presence of small bowel gas in cases of acute colonic obstruction signifies the supervention of peritonitis. In the vast majority of cases of acute obstruction of the colon, the large bowel alone is distended and no difficulty of differentiation is present; the absence of gas in the small bowel accompanied by a considerable distention of the large bowel is, in itself, excellent evidence that the obstruction is in the lower portion of the intestinal tract. When considerable distention of the small bowel is also present, rapid deflation by means of suction may be very helpful, as the colon will not deflate. The identity and size of the large bowel segments can then be better determined. In many cases, the administration of the barium enema may be necessary to clarify the position of the obstruction.

The roentgen examination may be of great value in determining the actual site of obstruction in certain cases, particularly those in which the obstruction is complete and is due to a tumefaction, either inflammatory or neoplastic. The column of gas under such circumstances can frequently be followed down to a point where the soft-tissue tumor mass itself is visible by contrast with the surrounding gas. This is particularly true on the right side of the abdomen. On the left side, the distention of the descending colon which tends to push down into the pelvis may cover up an obstruction in the sigmoid flexure or in the rectum to such an extent that it is difficult of delineation. Likewise, it is possible for the sigmoid flexure to descend into the pelvis in such a fashion as to simulate gas in the rectum. Such a situation may lead to a false diagnosis of no obstruction or of obstruction very low down in the rectum when, in fact, the obstruction is in the sigmoid or between the rectum and the sigmoid itself. A typical case in which the point of obstruction could readily be identified is illustrated in Figure 3. The column of gas distending the colon can be observed coming up to the region of the splenic flexure where a large soft-tissue

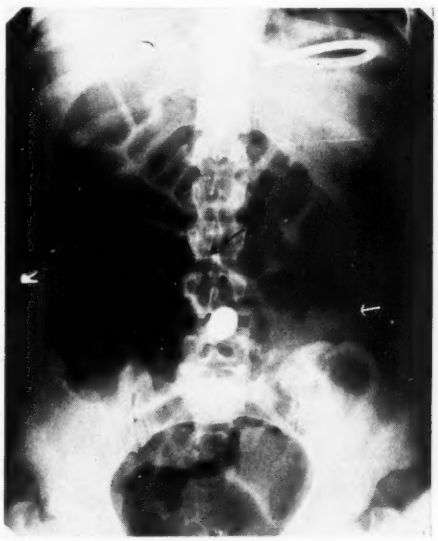

Fig. 3. Roentgenogram of abdomen, supine position, in a case of acute obstruction of the colon from carcinoma of the splenic flexure. Note column of gas stopping abruptly at soft-tissue density (arrow) which indicates location of tumor. Note gas in loops of small bowel (central arrow) due to pressure of tumor on small intestine rather than to regurgitation through the ileocecal valve.

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mass is apparent. It should be noted that the transverse colon, the hepatic flexure, the ascending colon, and the cecum are clearly delineated by the gas within them. The cecum is markedly distended. Near the mid-line and to the right several loops of small bowel distended with gas can readily be demonstrated and there is a considerable amount of gas in the pelvis, no doubt also due to other loops of small bowel. This is in contrast to the usual case of colonic obstruction. At operation there was found an extensive carcinomatous mass, arising in the splenic flexure, but extending far beyond the limits of the colon into the abdomen to compress the small intestine, thus producing a partial obstruction. As shown in this particular instance, it is difficult in many cases to be certain of the anatomic situation of the gas in the pelvis. It is possible that some of the gas here observed is also in the rectum. It should be noted at this point that it is not uncommon to find gas in the rectum and sigmoid, even in cases of complete obstruction of the colon higher up. This is commonly the result of the administration of enemas whereby gas is passed into the rectum itself where it may remain for some time. In many instances of obstruction of the colon, however, the occlusion is incomplete, permitting small amounts of gas to pass into the colon distal to the lesion and thus adding some confusion to the picture. Usually, however, this is not so important a factor because, regardless of the distribution of the gas, the distention lies proximal to the point of obstruction.

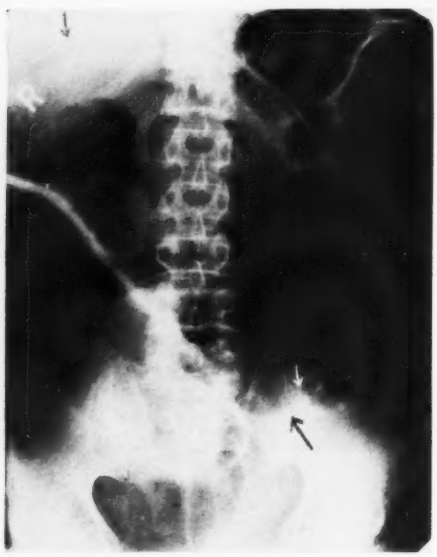

Fig. 4-*A*. Roentgenogram of abdomen, supine position, in a case of volvulus of sigmoid flexure with acute obstruction. The enormously distended sigmoid colon (arrows) is shown extending to the right and upward. The remainder of the colon is also distended but to a much lesser degree. Note the point of obstruction in the descending colon (white arrow) which must be proximal to the gas-filled sigmoid.

In the complex cases in which double obstructions are present, a more difficult problem is presented. In such instances, for example, in which there are two tumors, one in the descending colon and one in the sigmoid, or, as occasionally occurs, in which there is a diverticulitis in the sigmoid and a carcinoma at the rectosigmoidal juncture, two points of obstruction may occur. Under these circumstances it may be impossible, from scout films alone, to elucidate either the point of obstruction exactly or to determine definitely that there is an obstruction, because of the multiple columns of gas which are present in the colon. Here, again, the barium enema must be used in order to define clearly the nature of the process.

A consideration of the determination of the nature of obstruction necessitates some review of the possible causes of acute obstruction of the colon. Congenital lesions, no doubt, come into first consideration. These will not be discussed here in any detail because, in general, there is no diagnostic problem insofar as the obstruction itself is concerned. The chief importance of roentgen examination in cases of imperforate anus or atresia of the distal colon lies in the demonstration of the thickness of the septum which is occluding the lower bowel. The procedure to be undertaken here has already been described by Wangensteen and Rice. It consists essentially of making a film of the infant in the completely inverted position and at the same

time placing a metal marker, such as a thermometer, in the anal dimple as deeply as it can be placed. The result is that the gas in the sigmoid and rectum tends to extend toward the anal orifice to the fullest extent possible and the dense shadow separating the metal marker and the upper limit of the gas column gives a rough indication of the thickness of the wall through which surgery must be done in order to complete the continuity of the intestinal canal.

In the series of cases of acute obstruction of the colon here under consideration, numerous causes of obstruction other than the congenital lesions have been encountered. These include as the most common cause, obviously, neglected carcinoma in various portions of the colon. It should be observed that carcinoma of the rectum is not a common cause of acute obstruction. In addition, however, there have been cases of diverticulitis with an inflammatory mass completely obstructing the colon, extrinsic carcinomas, such as carcinoma of the prostate with involvement of the intraperitoneal glands and extension into the colon, carcinoma of the female generative organs with a similar process, nonmalignant tumor masses in the abdomen which compress the colon markedly, and benign tumors of the colon itself. It is obvious at once that roentgen examination alone, without the use of a contrast medium, does not permit the determination of the nature of the etiology in the above mentioned types of cases. If it seems necessary to determine the exact cause of the obstruction before operation, further examination with the barium enema must be undertaken.

There is, however, a type of large bowel obstruction which is amenable to diagnosis by simple films and to which we wish to call particular attention. This is the acute obstruction incident to a volvulus of the sigmoid colon occurring most commonly in individuals with a long, redundant flexure. It is possibly a more common cause of obstruction than is generally believed. No doubt many cases of volvulus of the sigmoid flexure restore themselves spontaneously, hence it is frequently not diagnosed. Attention should also be directed to the occurrence of volvulus as a complication of congenital megacolon (Hirschsprung's disease), two cases of which we have observed. Much has been written in the literature regarding the nature, pathology, and the mechanics of volvulus of the sigmoid and it is unnecessary to dilate upon this phase of the matter at this time. Suffice it to say that when it is the cause of an acute obstruction, being non-malignant, early treatment is of great value; the life of the individual and his future health may readily be conserved if surgery is instituted before the effect of the obstruction itself makes it hopeless. Hence, it is extremely important to make an early diagnosis in such instances. That this can be done in almost all cases is demonstrated by the reports in the literature of roentgen diagnosis of volvulus of the colon and by our own experience in the six cases which we have encountered.

An examination of the films in our six cases of acute volvulus of the sigmoid flexure convinces us that the diagnosis should have been made in each case, although we regret to say it was not, from the simple films of the abdomen alone, especially when films in upright or lateral decubitus positions were obtained. The most pertinent feature of the roentgen findings is the tremendous distention of the sigmoid flexure which pushes well out of the pelvis, almost always to the right side, right to the edge of the liver, often up to the diaphragm. The proximal portion of the colon is only moderately distended, but the descending portion may be considerably enlarged. Usually the obstruction in these instances is of a valve type, hence may be somewhat intermittent. Furthermore, it is possible to inject material from below past the obstructing point but gas and fluid cannot pass from the proximal side of the obstruction. The second most important feature in the diagnosis of volvulus of the sigmoid is the tremendous accumulation of fluid which

occurs in this portion of the colon. For practical purposes the sigmoid becomes a closed loop in itself because of the double rises to the left, sometimes extending under the left diaphragm rather than to the right and, obviously, the absence of symptoms

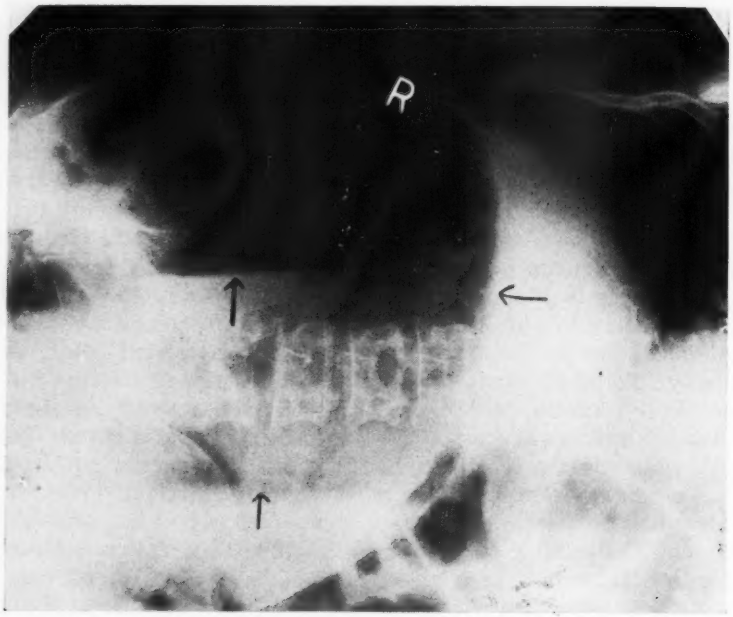

Fig. 4-*B*. Roentgenogram of abdomen, left lateral decubitus position, same case as Figure 4-*A*. The enormously distended sigmoid is shown with two fluid levels (arrows) visible because of the position in which the film was made.

obstruction due to twisting on its axis. The unusual amount of fluid may be demonstrated by films made either in the upright or in the lateral decubitus position. Often a double fluid level can be made out because of the enormous size of the sigmoid which extends over the spine in such a fashion as to give the appearance of two separate loops. Finally, two points of obstruction to the gas column may be made out. When a double point of obstruction occurs, it is, with the exception of the rare cases of two lesions, usually the result of a volvulus.

There is scarcely any other condition which may simulate this situation. Patients with megacolon, while not acutely obstructed, may show distention of the sigmoid with large amounts of gas. However, under such circumstances the entire colon is somewhat distended. The sigmoid of acute obstruction helps in making the differentiation.

In such instances it is desirable to obtain absolute confirmation of the diagnosis as it may affect the treatment seriously. Hence a barium enema should also be given after the suspicion of acute volvulus is entertained from the scout films of the abdomen. When this is done, the tremendously distended sigmoid may usually be demonstrated and the double point of obstruction may be clearly delineated. Changes in the mucous membrane pattern of the colon can often be seen at the site of the twist itself. This should serve to confirm the diagnosis unequivocally and indicate the line of treatment which must be pursued.

A typical case illustrating some of these points is shown in Figure 4-*A*. The enormous dilatation of the sigmoid flexure, projecting well over to the right (upper

arrow), with a relatively moderate distention of the remainder of the colon, is clearly apparent. The sigmoid fills a large portion of the right side of the abdomen but extends to the left as well (lower arrow); superimposed upon its shadow is that of the ascending colon and hepatic flexure partially filled by fecal material and gas. There is also a considerable distention of the descending colon. A point of obstruction in the descending colon can be seen just to the left of the left sacro-iliac joint (white arrow). This point of obstruction could scarcely occur with an enormously distended sigmoid distal to it unless there were another point of obstruction lower down. The latter is not well shown in this film although in some instances it can also be demonstrated. The double obstruction, together with the enormous distention of the sigmoid and the relatively moderate distention of the remainder of the colon, is practically diagnostic. Another roentgenogram of the same case made in the left lateral decubitus position is shown in Figure 4-*B*. The upper level of the sigmoid is indicated here and the double fluid level within the sigmoid flexure itself is shown by the two arrows. The addition of these findings to those demonstrated in Figure 4-*A* is confirmatory. The upright roentgenogram in another case is shown in Figure 5. Here, again, the enormous distention of the sigmoid with its tendency to extend to the right side is shown. The massive amount of fluid is indicated by the dense shadow (arrow) in contrast with the gas above it. An attempt to do a barium enema examination revealed only the lower point of obstruction (lowest arrow) but no material could be forced proximal to this point, as it was not of the valvular type.

A third case is illustrated in Figures 6-*A* and 6-*B*. In this instance the patient was suffering from constipation and intermittent attacks of acute pain but there were no real evidences of obstruction. He was examined with the barium enema on repeated occasions, the last being on Feb. 26, 1938. There was no evidence of volvulus at this time, and no signs of acute obstruction. The roentgenogram after evacuation is illustrated in Figure 6-*A*

Fig. 5. Roentgenogram of abdomen, upright position, in a case of volvulus of the sigmoid with acute obstruction. The outlines of the tremendous sigmoid colon, extending over to the right and upward, are shown by the lateral arrows. Note the large amount of fluid and the level shown in this position (arrow). Barium sulphate in the rectum is also shown with the distal obstruction indicated by the lowest arrow.

and shows the sigmoid flexure as a long organ rising somewhat to the right side. The various portions of the colon and bowel are marked appropriately in the figure. Seven months later, the patient came in with a history of acute abdominal pain and absence of bowel movements for a three-day period. The abdomen was distended. A scout film of the abdomen, which is not illustrated here, showed essentially the typical findings of volvulus of the sigmoid already described. The colon, however, was not as large as in the other cases here illustrated. Barium enema examination was undertaken and the results are illustrated in Figure 6-*B*. The point of obstruction as the barium enters the sigmoid colon from the rectum is well shown, and the twisting of the colon is quite in evi-

dence. The sigmoid is dilated and has a very large loop extending upward well out of the pelvis into the abdomen. The second point of obstruction beyond which none of the enema would pass is also shown. The typical appearance of volvulus of the sigmoid as demonstrated by barium enema examination is shown in this film. At operation the flexure was twisted on its axis to the extent of 270°, the obstruction being incomplete.

It is evident then, that a careful study of scout films of the abdomen should at least stimulate the suggestion that a volvulus of the sigmoid is present. Further investigation with the use of the barium enema will serve to confirm the diagnosis completely and indicate plainly the course of therapy to be instituted.

In the consideration of acute obstruction of the colon, one other matter is of considerable importance. This relates to the possibility of perforation of the colon. As has been well demonstrated recently by Wangensteen and others, this is, no doubt, the most serious complication of acute obstruction of the colon. Perforations most commonly occur in the cecum, but occasionally also at the site of the lesion, particularly if the source of obstruction is an inflammatory process or a carcinoma of the colon itself. In many instances, either because of reluctance on the part of the patient to submit to operation or because of other considerations, conservative treatment must be undertaken in the presence of an acute obstruction. In such cases it is extremely important to observe the pa-

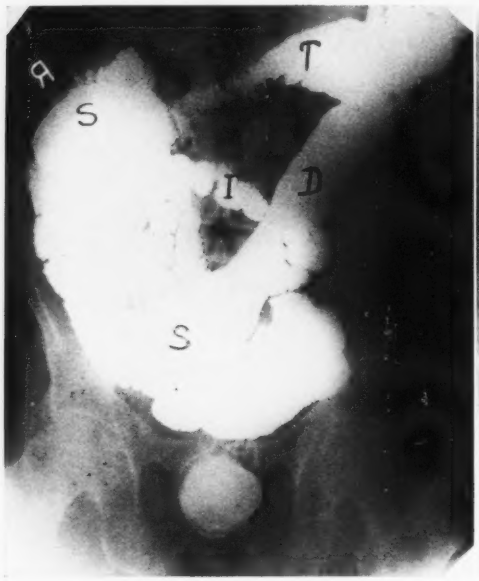

Fig. 6-*A*.

Fig. 6-*B*.

Fig. 6-*A*. Roentgenogram of colon, after partial evacuation of the barium enema, in a case of redundancy of the sigmoid. Note the moderate size of the descending (*D*) and transverse (*T*) portions of the colon. The sigmoid flexure (*S*) is greatly elongated and extends to the right overlying the cecum. The ileum (*I*) has been filled. There was no acute obstruction at this time.

Fig. 6-*B*. Same case as in Figure 6-*A*, seven months later, during an attack of acute obstruction from volvulus. Barium enema examination is incomplete owing to the obstruction. Note the distal point of obstruction (upper arrow) indicating the twisting of the colon. The sigmoid flexure is distended but some of the mixture passes through the distal obstruction, pushing the gas proximally to reveal the proximal point of obstruction (lower arrow) beyond which none of the contrast medium could be forced. At operation there was found a 270° twist of the sigmoid flexure, the obstruction being incomplete.

tient at frequent intervals by repeated examinations of the abdomen to determine whether or not distention of the cecum is approaching the point of perforation. The latter, of course, cannot be estimated with any great degree of accuracy, but the development of a high degree of distention, as illustrated in Figure 1, should always arouse the thought that perforation is imminent.

The occurrence of perforation will manifest itself, roentgenologically, by the demonstration of free gas in the peritoneal cavity. In our experience, pneumoperitoneum has been evident in all cases of perforation of the colon; this is in contrast to perforations of the small intestine or of the stomach, in which an appreciable number of cases, as high as 25 per cent, do not give clear evidences of free gas in the peritoneal cavity.

The usual methods for the demonstration of free gas in the peritoneal cavity are familiar to all and have been repeatedly described. Essentially these consist of making roentgenograms in the upright or lateral decubitus position so that gas can be seen under the diaphragms or within the lateral abdominal wall. It should be pointed out, however, that if large quantities of free gas escape from the bowel into the peritoneal cavity, together with some fluid, as is almost invariably the case in perforations of the colon, roentgen examination at the bedside, in the usual supine position, will reveal evidences which are perfectly clear. The ordinary scout film of the abdomen, without upright or lateral decubitus films, will be sufficient for this purpose. The evidence adduced in this way consists of the ability to visualize the outer as well as the inner wall of the small bowel together with the signs of ileus which occur immediately after perforation of the bowel has taken place. The details of these signs of perforation will be discussed in a later paper, but it should be emphasized that it is valuable to examine repeatedly patients who are suspected of acute obstruction of the colon in order to determine the diagnosis of perforation at the earliest possible moment. In many instances because of the serious condition of the patient, the clinical findings, which should signalize the onset of perforation, are not striking, hence early roentgen diagnosis becomes doubly important. If repeated examinations are being made as a routine, in occasional cases, the observations described above will be the first indication that perforation has occurred.

SUMMARY

Roentgen examination of the abdomen without contrast medium, preferably in the supine and upright positions, is of great value in the diagnosis and treatment of cases of acute obstruction of the colon.

By this means, valuable information may be obtained which will help in the determination of the diagnosis, differentiation from other acute abdominal conditions, such as adynamic ileus, and obstruction of the small intestine.

In certain cases, the site of obstruction may be observed.

The diagnosis of acute volvulus of the sigmoid may be made by the size and position of the sigmoid flexure, the presence of unusual amounts of fluid, and the demonstration of a double point of obstruction.

In some cases, barium enema examination must be undertaken to make the diagnosis more certain.

When surgery is not done at once, repeated roentgenograms should be made to observe the degree of distention of the cecum in order to determine the possibility of perforation.

The supervention of perforation can be determined in routine roentgenograms with the patient supine by the appearance of the loops of the small intestine. These become distended with gas and exhibit the shadow of their outer as well as their inner walls.

THE BEHAVIOR OF THE SMALL INTESTINE DURING URINARY TRACT IRRITATION[1]

By KENNETH D. A. ALLEN, M.D., *and* JOHN H. JAMISON, M.D., *Denver, Colorado*

UROLOGISTS and radiologists have recognized for years that irritation of the urinary tract seemed to cause intestinal gas to appear in urograms; that patients with ureteral or kidney pelvis stones, pyelitis, and ureteral catheters in place suffered from meteorism. Few have published articles on this subject. A review of the recent medical literature yields little or no proof that urinary tract irritation does cause the presence of gas in the intestinal tract, though most of the authors imply that it does cause meteorism, distention, and flatus. Few, if any, state whether meteorism means gas in the stomach, small intestine, colon, or in all of these structures. The discussions of investigators are confined mainly to the cause and treatment.

The purpose of this paper is to determine the incidence and amount of gas in the small intestine in a number of cases of known urinary tract irritation, and to compare this determination with the findings in a like number of cases with no known irritation. A total of 500 x-ray examinations were studied—250 of the irritative type and 250 apparently normal.

Since gas in the small intestine in amounts demonstrable by x-ray examination is an abnormal condition in patients beyond infancy, information concerning its presence here is more important than in either the stomach or colon, and, therefore, our attention has been directed to gas in the small intestine.

Cases classified as having urinary tract irritation had either a demonstrable ureteral or kidney pelvis stone, or a catheter present in the bladder and ureter. Many of those with a catheter were negative for urinary disease.

Those cases classified as not having urinary irritation gave no roentgen or clinical evidence of recent urinary tract disease. Second-day plates in gastro-intestinal studies were used. Each patient had his meals as usual except lunch the first day which consisted of only barium and buttermilk or barium and water for some; others ate lunch after the fluoroscopic and x-ray studies were completed the first day. Practically all had their usual breakfast and dinner the first day and all had meals as usual the second day.

Patients with gastro-intestinal symptoms do not have *less* meteorism than patients with no urinary and no gastro-intestinal symptoms. Thus it will be seen that second-day gastric studies are satisfactory normals for purposes of comparison in this study. Indeed, it would be a difficult task to discover 250 adults with no urinary and no gastro-intestinal difficulties.

In making the survey, each case was recorded according to the grade or amount of gas present. The usual method of four grades was used as follows:

Grade I.....A single loop six inches long or less.
Grade II.... One loop six inches plus or two small loops.
Grade III... More than two loops, each six inches or more in length.
Grade IV....Multiple loops filling the abdomen.

TABLE I

	Gas in Small Intestine
250 Cases of Known Irritation of Urinary Tract	113 cases, or 45.2%
250 Cases without Urinary Tract Abnormality	3 cases, or 1.2%

Table I indicates that of the 250 urograms in which a stone was visualized

[1] Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

either in the true pelvis of the kidney or the ureter, or in which a catheter was seen in one or both ureters, 45.2 per cent showed a definite amount of gas in the small intestine, while in the urologically normal control cases only 1.2 per cent showed gas in any portion of the small intestine.

The 45.2 per cent of cases showing small intestine gas may be a conservative determination. Relatively few of the irritative cases were the result of calculus. The majority were catheterized cases. In most, the catheters had been in place less than 30 minutes. Longer duration of the irritation might conceivably have caused gas to appear in some of those recorded as negative, thus raising the percentage.

Of the cases which had gas in the small intestine, 69 were Grade I, 32 were Grade II, 11 were Grade III, and 1 was Grade IV.

Occasionally the accumulation of gas in urinary irritation cases is so great that small intestine obstruction is suspected; these are among the Grade III and IV cases. Generally, mechanical obstruction can be excluded because the urinary cases show (*a*) much less dilatation; (*b*) fewer loops involved, and (*c*) the colon contains more gas than the average normal case, whereas in mechanical obstruction the colon soon shows less gas than the average normal. The history is also a differentiating factor.

Of those in the group of 250 cases which were catheterized, 39 cases were roentgenographed immediately before catheterization. Of this small number, 11, or 28.2 per cent, showed small intestine gas before introduction of the catheter, and 19, or 48.7 per cent, after its introduction. Some of those depicted before the introduction of the catheter were, of course, already suffering from some form of urinary tract inflammation. At least two of those who showed gas in the small intestine before catheterization had stones in the ureter. Of this group nine cases which had no gas before catheterization had gas in the small intestine after the catheters were introduced. Thus small intestine gas made its appearance in demonstrable amounts in less than 30 minutes in nine out of 39 cases.

CONCLUSIONS

1. A total of 500 x-ray examinations showing the small intestine region are reviewed, 250 of which had known urinary tract irritation, while 250 were believed to be free of such a condition.

2. In the irritative group, 45.2 per cent had demonstrable gas in the small intestine, while of the non-irritative group only 1.2 per cent had any roentgen signs of gas.

THE RÔLE OF INTESTINAL INTUBATION IN THE DIAGNOSIS AND LOCALIZATION OF INTESTINAL OBSTRUCTION[1, 2]

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From the Wayne University College of Medicine, and Detroit Receiving Hospital

THE use of gastroduodenal siphonage, as advocated by Ward (19), Wangensteen (18), and others, opened new avenues of approach to the treatment of acute intestinal obstruction. Previously, reliance had to be placed solely on surgical intervention. This type of suction, however, had definite limitations which have been overcome by the utilization of the Miller and Abbott balloon-tipped tube (2, 11), first successfully applied to the treatment of intestinal obstruction by Abbott and Johnston (1).

About a year ago, we first presented the results of our studies of the small bowel by means of intestinal intubation (10). At this time it is our desire to present additional data, with special reference to acute intestinal obstruction.

The consideration of the acute abdomen presents a series of complexities in which the surgeon finds it necessary to rely not only on the clinical picture but also on all available laboratory and roentgenologic aid in establishing the proper diagnosis. Fortunately, in the large group of cases suffering from acute intestinal obstruction, the roentgenologist has been able to make a substantial contribution. According to Wangensteen, the roentgenograph of the abdomen provides more reliable information relative to the presence of an obstructive process than any other laboratory procedure. By roentgenographic means, the diagnosis of acute intestinal obstruction can be made accurately within a few hours after the onset of symptoms. This has been brought about through the application of the survey film of the abdomen, in upright and supine positions, in a search for gas collections in the small bowel. This criterion, established by Schwarz (15) and Guillaume (7), is fundamental. The only progress since their work has been through the addition of certain details which have contributed accuracy and finesse not then known. Case (4) identified the typical pattern produced by the various sectors of the bowel when distended by gas. The location in the abdomen of the various portions of the small intestine was shown by Cole (5, 6) to be of assistance in determining the position of the obstruction. The work of Wangensteen and his coworkers (3, 17, 18) and Ochsner and Granger (13), together with many other investigators, has contributed a vast amount of valuable experimental and clinical information which has served to make the roentgenograph a dependable adjuvant to our diagnostic armamentarium.

However, up to this point it was possible to make only a rough estimate of the probable third of the small bowel in which the occlusion was situated. It was also exceedingly dangerous to introduce an opaque medium into the lumen of the bowel because of the danger of converting a partial into a complete obstruction.

It was not until Abbott and Johnston (1) utilized the balloon-tipped tube in the treatment of paralytic ileus and intestinal obstruction that a method of localizing definitely the obstructing point was made available. They found that such a tube as that designed by Miller and Abbott (2, 11) could be introduced into the distended bowel and decompression be effected as the tube progressed along the gut to the obstructed point. The balloon

[1] Aided by a grant from the Committee on Scientific Research of the American Medical Association.

[2] Read before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

fixed near the tip of the tube (18 Fr.) facilitates its passage, as peristalsis readily grips the inflated balloon, propelling it onward and dragging the remainder of the

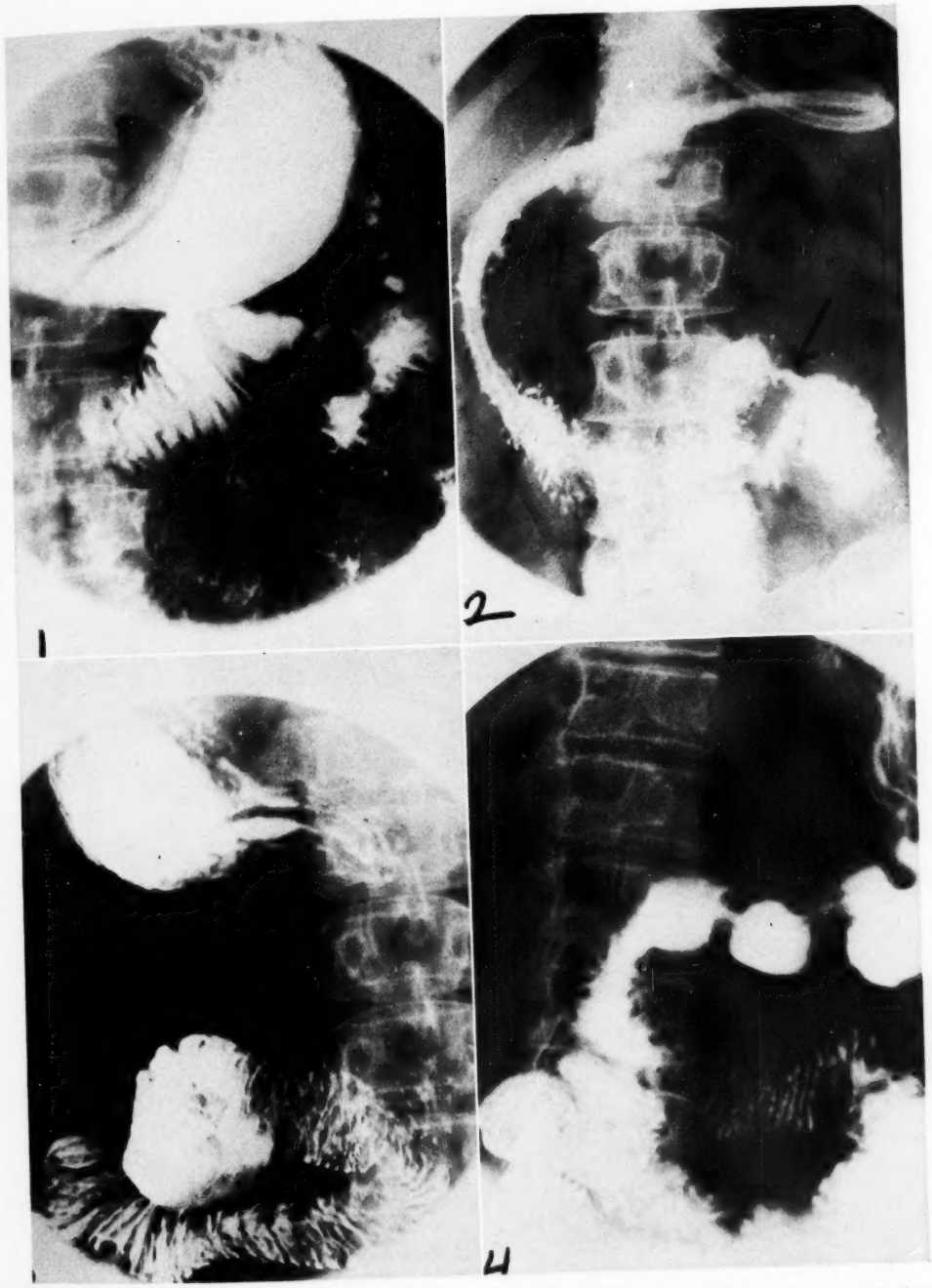

Fig. 1. (D. S.) Serial films illustrating barium localization of a neoplasm just distal to ligament of Treitz.

tube behind it. Complete descriptions of the technic of intestinal intubation in paralytic ileus and intestinal obstruction have been made by Johnston, Noer, and

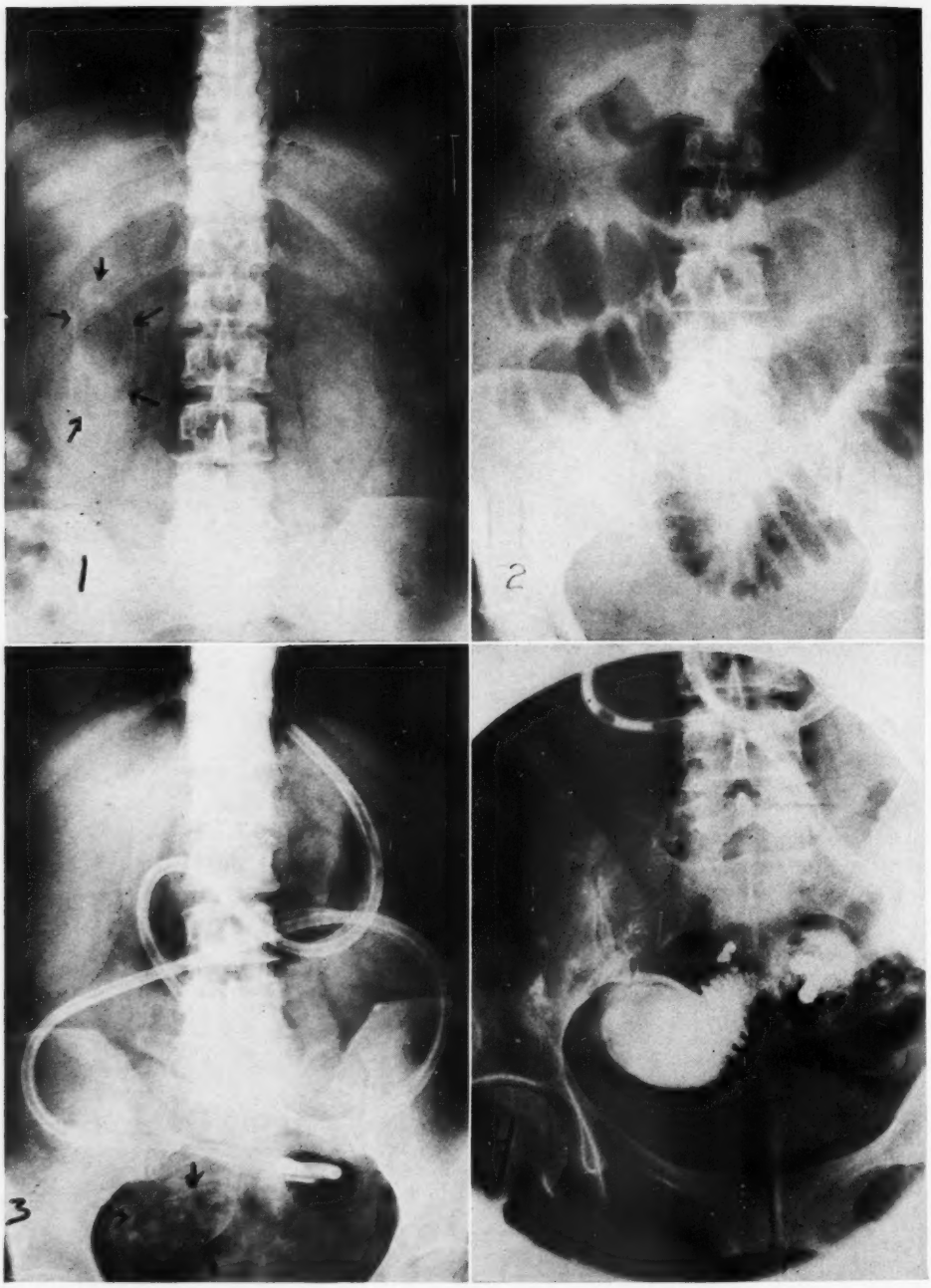

Fig. 2. (A. G.) Gallstone obstruction of small intestine. Note stone in Nos. 1 and 3 (both after decompression). No. 2 shows distention on admission and No. 4 shows complete obstruction to passage of barium injected through the intestinal tube.

their associates (8, 9, 12, 14). They have reported a striking decrease in the mortality figures in such cases.

In our previous publication, we reported the use of intestinal intubation as a means of studying intestinal pattern and the pathologic processes producing a changed lumen of the intestinal tract. At that time we pointed out some of the pitfalls in the use of intubation; the dangers of coiling and clogging and the great need for very active co-operation between the roentgenologist and the surgeon. At this time we reiterate those points as being of the utmost importance, if the fullest advantages of the method are to be obtained.

Frequent roentgenoscopic and roentgenographic observations must be made to watch the progress of the tube through the bowel and to note the resulting degree of decompression. Of course, during the entire process, re-establishment of the vital fluid and chemical balance must be carried out by intravenous and oral administrations.

When it is found that the tube has ceased to progress and that gaseous and fluid accumulations have been removed and the patient is in a more normal physiologic state, localization studies may be inaugurated. These can now be accomplished without haste and without the dangers formerly associated with the introduction of barium into the obstructed bowel. The time factor is minimized because the medium is injected to the pathologic site and, should complete obstruction be present, the medium can be readily withdrawn. Also, a greater clarity of the pathologic site is attained, due to the elimination of superimposed barium-filled loops.

We are thus in a position to determine accurately the exact type and extent of the obstruction, together with any other complications present. Armed with this information, the surgeon is able to proceed in the indicated direction with greater confidence. In a fairly large number of cases, the complete alleviation of the obstruction can be demonstrated, thus eliminating a major surgical procedure. In those cases in which an operation is essential, the surgeon has a clearer picture of what is to be encountered upon opening the abdomen.

It is advantageous to examine every intubation case before the tube is withdrawn. Even though there are no adverse signs upon discontinuing suction, there is a possibility that obstruction will recur. If localization studies are carried out, this danger is eliminated because we may ascertain definitely the alleviation of the obstruction or the persistence of narrowing which should be treated surgically. Thus, if removal of the tube is indicated, it can be done with impunity.

The only contra-indication to intubation is strangulation obstruction. Age has not proved a factor: our youngest patient was an infant three years of age, our oldest in the late seventies.

The contrast medium of choice is a barium suspension, in water, of a consistency just able to permit its passage through the tube. We have been fortunate in obtaining a colloidal barium sulphate which will remain in suspension for many hours. This gives us a relatively homogeneous shadow which is an asset in properly visualizing defective areas.

The maneuver is carried out under roentgenoscopic observation with serial films taken for better detail. The spot film device is of definite value in obtaining localized views of the mucosal surface. There can be no fixed rule regarding the number of films taken or the length of the intervals between them. We have observed that the intubated bowel is less active than normal, and, therefore, it may require several hours for the medium to pass only a few feet in the ileum, even in the absence of an obstruction or other abnormality. We routinely follow the barium column until it passes completely into the colon.

When no evidence of obstruction or pathology is detected, we allow the tube to be clamped and then proceed to do serial studies by means of oral administration of barium. This is done to eliminate the possibility of the balloon's having

passed beyond the obstructive point, which was made incomplete by decompression. On one occasion an obstruction developed above the balloon several days after it had

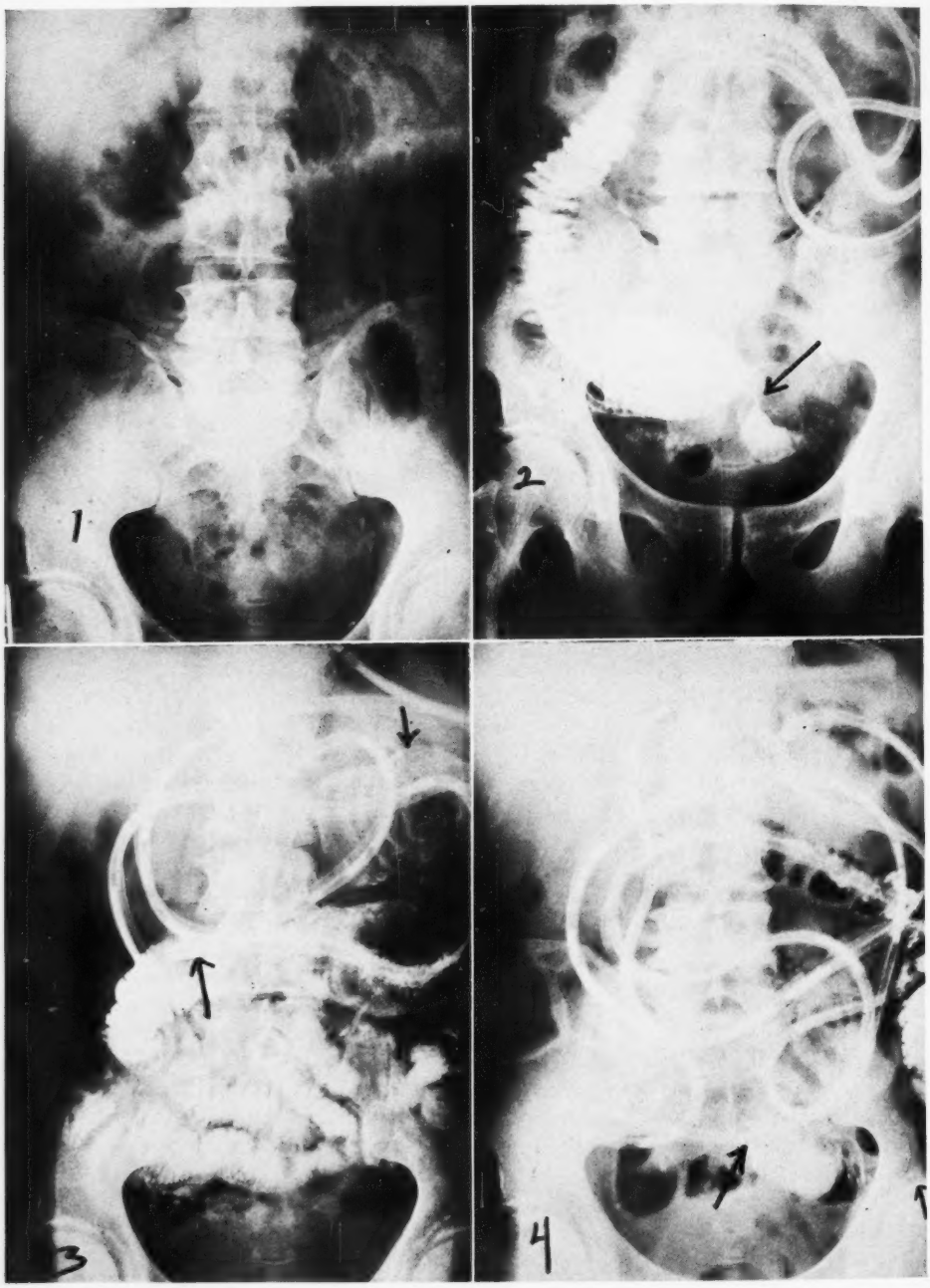

Fig. 3. (P. S.) Multiple obstructive areas in ileum due to ileitis. No. 1 shows distention on admission. Nos. 2 and 4 reveal areas of narrowing revealed by barium injected through the intestinal tube. Arrows in No. 3 show dilatation of intestine proximal to obstructive parts.

been in place, and was detected in this manner.

Aside from the simple factor of an encroachment upon the lumen, additional signs of a more generalized process may be noted. In several cases it was possible to determine the presence of fairly extensive adhesions with large matted areas of bowel. Careful palpation with displacement of all loops should be carried out in every case to detect such conditions as these. Multiple areas of narrowing may be encountered and should be watched for.

The tube may be used to advantage in any sector from the duodenum to the terminal ileum. When the superimposed barium-filled stomach obliterates an area in the duodenum, the tube again enables the introduction of barium directly to the involved point and unobstructed view is afforded. In this series of studies, a case of lymphosarcomatous obstruction in the vicinity of the ligament of Treitz was easily visualized by this method.

Aside from the few cases mentioned, we have encountered a number of cases of simple adhesive-band compression, ileitis, and two gallstone obstructions in the ileum.

It should be borne in mind that, because of the use of constant siphonage, all of these cases, when localization studies were made, were not in an acute condition but rather in an essentially normal physiologic state.

Although not within the scope of this paper, other less critical conditions, such as unobstructing ileitis, cancer, diverticulum, and systemic disease manifesting itself in an aberration of the mucosal pattern, may be studied advantageously by the use of intestinal intubation. Double contrast by injection of air and barium in the latter type is of definite value, mucosal relief being produced.

The following case reports and roentgenographic findings represent a few of the conditions studied.

D. S., 57-year-old white woman, gave a one-year history of nagging epigastric pain after meals. One month before admission she began to vomit everything eaten and her pain ceased. She was constipated for one month. Physical examination revealed little of interest. X-ray examination of the gastro-intestinal tract gave evidence of an obstructed point in the third portion of the duodenum. For better localization, the tip of the tube was passed to the third portion of the duodenum; barium studies were strongly suggestive of carcinoma of the duodenum. On Aug. 22, 1938, exploration was undertaken and a tumor mass was found 3 in. distal to the ligament of Treitz, resected, and an end-to-end anastomosis done. The patient made a good convalescence from this procedure and was sent to another hospital for post-operative x-ray therapy.

A. G., 67-year-old white woman, had had sudden epigastric pain for five days. This eased up after two days but again recurred and was persistent and cramp-like until admission. There was vomiting with any fluid or food intake. The patient was moderately distended, with generalized muscle spasm and some tenderness, especially in the right upper quadrant. Peristalsis was hyperactive and high pitched. There was a fullness suggesting a mass in the right upper quadrant. X-ray examination showed no distention but in six days there was marked gaseous dilatation of the jejunum and upper ileum. The tube was passed into the small bowel for complete decompression. Gallstone obstruction was then localized by x-ray examination. On July 28, operation was performed and a gallstone removed from the intestine. The post-operative course was good for three days when she became weaker, then steadily lost ground, and expired the fifth post-operative day. Autopsy revealed a chronic cholecystoduodenal fistula and adhesions causing partial but not complete intestinal obstruction. The cause of death was not apparent from the autopsy, but it was felt to be circulatory in nature.

P. S., 56-year-old white male, developed sharp stabbing generalized abdominal pain one month before admission. This pain

lasted four or five days and disappeared but recurred three times during the interval, each attack lasting about three days. Twelve days before admission, similar pain again recurred, this time associated with vomiting and constipation. On admission, the abdomen was somewhat distended, peristalsis was hyperactive, x-ray examination showed marked gaseous distention of the small bowel. He was decompressed with the long tube, and barium localization revealed partial obstruction in the terminal third of the ileum. On Sept. 21, 1939, operation was carried out, at which time findings included (1) chronic ileitis, (2) diverticulum of the bladder with adhesions to the ileum, and (3) ileorectal fistula. The procedures carried out included lysis of adhesions, closure of the fistulous tract, suture of the bladder, and biopsy of the ileum which revealed chronic ulcerative ileitis. Recovery was protracted, complicated by nutritional difficulties. He eventually left the hospital in good condition. He has just been re-admitted and our first barium studies without intubation reveal at least three points of partial obstruction in the middle and lower ileum, presumably on the basis of ileitis.

T. B., 32-year-old white male, underwent an appendectomy and was discharged from the hospital five days before the present admission, after an uneventful recovery. The night he arrived home he suffered severe cramp-like abdominal pain and was brought back to the hospital with marked distention the following day. X-ray examination revealed marked small intestinal dilatation. He was successfully decompressed by intestinal intubation, after which barium given through the tube demonstrated a localized area of ileitis with stenosis in the terminal ileum. De-

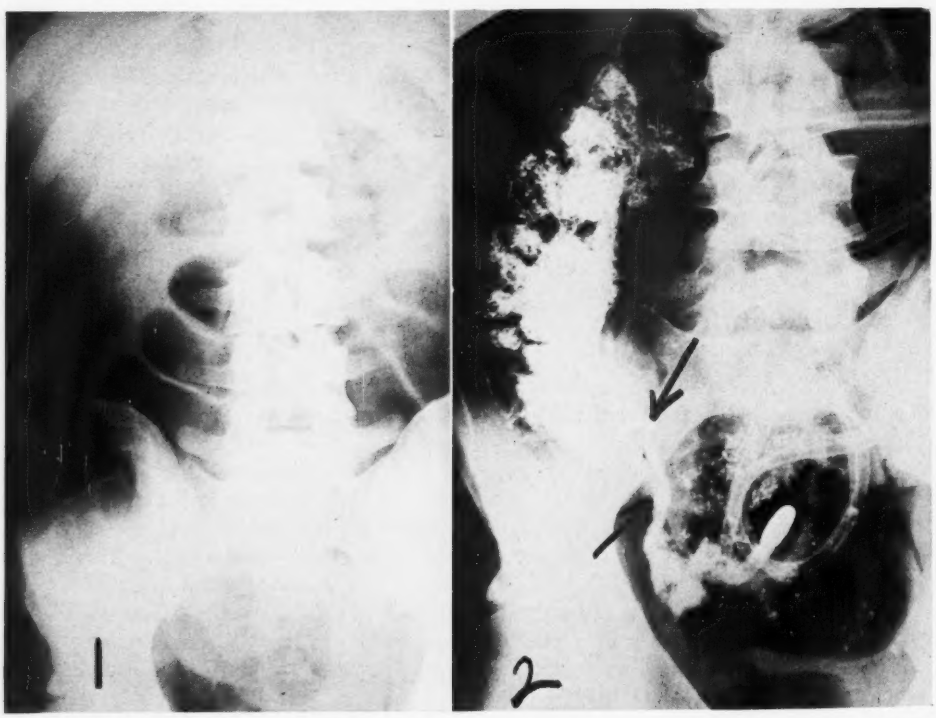

Fig. 4. (T. B.) Early post-operative obstruction, presumably due to adhesions. No. 1 reveals distention, No. 2 the area of narrowing in the terminal ileum.

compression relieved his symptoms and it was possible to remove his tube without recurrence of distention. Since this was an early post-operative process, it was

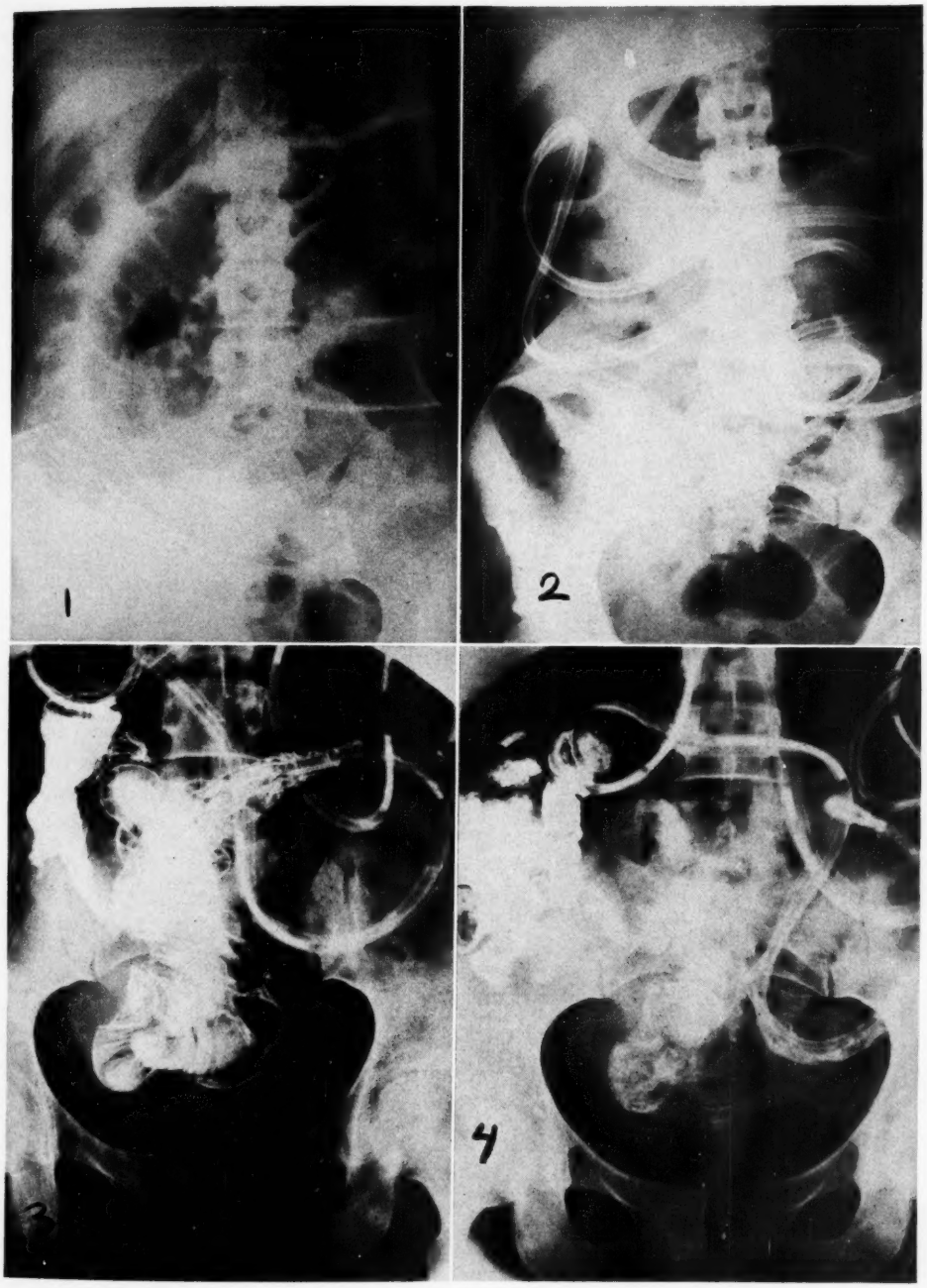

Fig. 5. (A. N.) Intestinal obstruction due to pelvic abscess subsequent to a vaginal hysterectomy. No. 1 reveals the distention before treatment, No. 2 the tube in place after decompression, and Nos. 3 and 4 the localization of the obstruction.

felt that he might undergo spontaneous recovery and surgery was, accordingly, not undertaken. He has since gotten along very well.

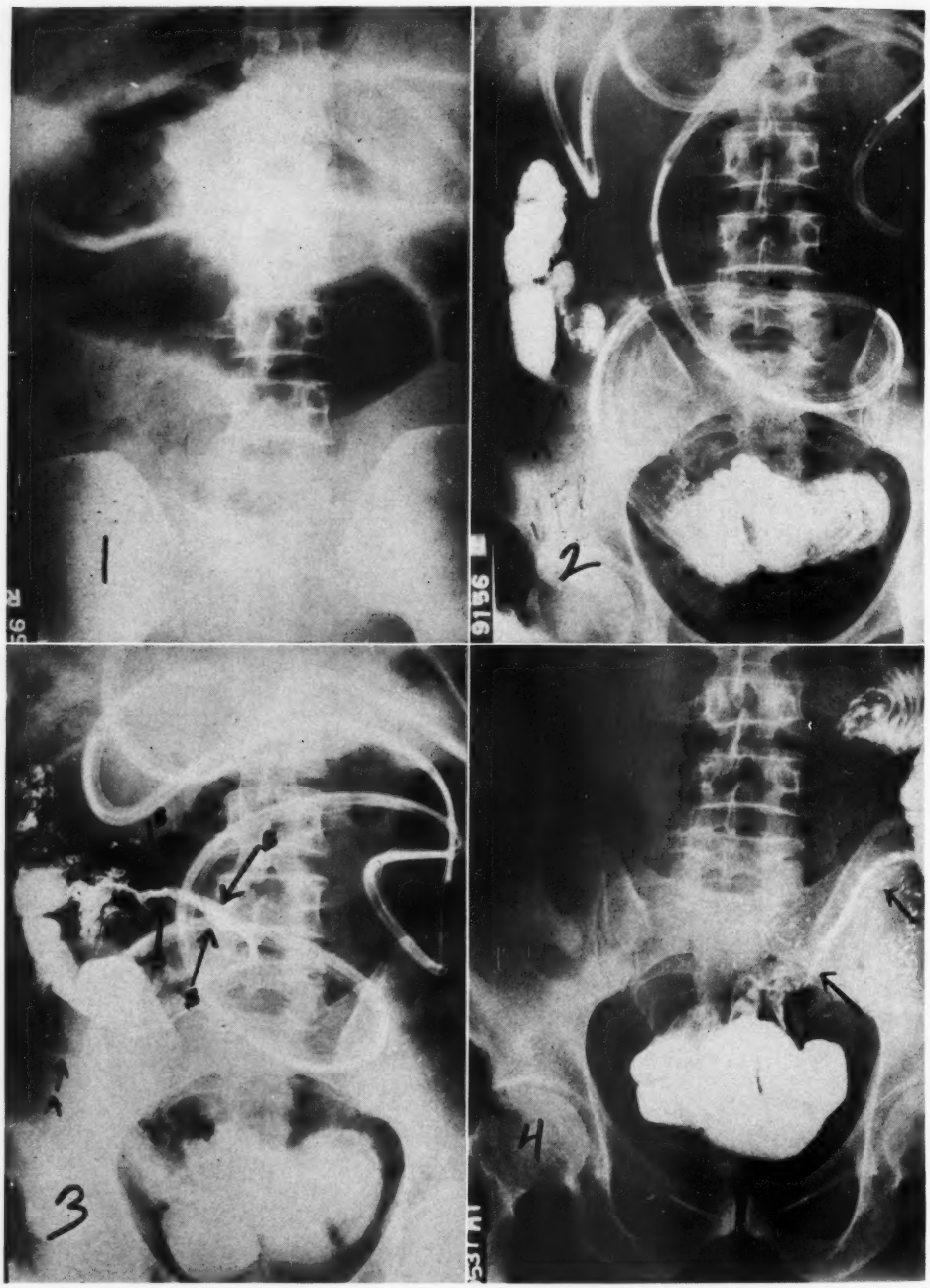

Fig. 6. (J. F.) Recurrent intestinal obstruction due to ileitis. No. 1 shows distention before intubation, Nos. 2 and 3 an area of ileitis in the terminal ileum which was resected. No. 4 shows an area of narrowing in the jejunum first demonstrated 15 months after the resection of the ileum.

A. M., 30-year-old Negress, underwent a vaginal hysterectomy. She ran a stormy post-operative course complicated by infection. Marked distention occurred about a month after admission. Following decompression with the long tube, barium given through the tube revealed evidence of partial obstruction of the ileum from eight to ten inches above the cecum. After evacuation of a pelvic abscess by means of a colpotomy, she made a good convalescence without further evidence of intestinal obstruction.

J. F., white male, aged 37 years, one month following a Mikulicz type of resection for a neoplasm of the sigmoid, developed distention and evidence of intestinal obstruction. Long-tube decompression was carried out, following which barium given through the tube demonstrated two obstructive areas in the terminal ileum. Operation confirmed this, revealing marked adhesions around the ileum with inflammatory involvement of the wall of the ileum for which resection was necessary. He made a good convalescence from this procedure and did well for a considerable period of time. However, he recently returned to the hospital complaining of vague abdominal discomfort at times. Gastro-intestinal series revealed two areas of ileitis, one in the jejunum and one in the ileum. Since it did not seem advisable at this time to carry out any active therapy, he has simply been treated by conservative measures and so far is getting along reasonably well.

CONCLUSION

Small intestinal intubation has been a distinct aid in the more accurate diagnosis of acute intestinal obstruction.

1. The decompression of the distended bowel by the use of the Miller-Abbott tube is a major factor in reducing mortality.
2. After decompression, the safe administration of barium through the tube to the occluded point is possible.
3. The nature of the obstruction can be studied and disclosed to the surgeon.
4. A number of cases following intubation will be found to be free of obstruction, obviating the necessity of a dangerous surgical procedure.

We wish to express our appreciation to Dr. Charles G. Johnston and Dr. J. C. Kenning for their very helpful criticism, advice, and assistance in carrying out these studies and in preparing this material.

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DISCUSSION OF SYMPOSIUM ON ROENTGEN DIAGNOSIS OF ACUTE INTESTINAL CONDITIONS

GEORGE HOLMES, M.D. (Boston): I regret very much that circumstances were such that I was not able to hear all of the papers that have been presented in this symposium. I was able to be present only during the presentation of the last two. I did, however, have the privilege of reading most of the other papers. In comparing the presentations with the papers that I read, I find that there is quite a difference and I hesitate somewhat to discuss the papers that I did not hear.

This symposium, to me, is a timely and splendid presentation. The introduction of the Miller-Abbott tube into the therapeutic procedures in obstructions of the small bowel has not only resulted in a tremendous reduction in the mortality of this group of cases, but it has raised a problem for the roentgenologists which we did not have before and in which we certainly need the instruction which the essayists here to-day have given us.

Our experience in Boston has been practically the same as Dr. Golden's, concerning the success with which this tube can be used and in the end-results. I shall not attempt to add anything to what he has said: I hope you can remember it as he gave it, which, to me, was a beautiful demonstration.

The papers from Dr. Rigler's clinic are all excellent and along very much the same line. There were one or two things, however, which I would like to emphasize or perhaps ask a question about.

Dr. Rigler presented two cases of unexplained dilatation of the colon. We have seen a similar condition in persons with syphilis of the central nervous system —particularly the mental type—and I wonder if his cases could possibly belong to that group.

I would also like to emphasize another group of cases in which obstruction of the large bowel occurs, but which Dr. Rigler probably did not have time to take up, namely, cases of diverticulitis with obstruction. This is a condition which, as you know, occurs most often in older patients—persons who are not particularly good operative risks—and we have found that, in this group, often rest in bed with proper treatment will clear up the obstruction in a matter of a week or ten days, and that the patients make an uneventful recovery.

The differentiation, then, between obstruction from carcinoma of the colon and obstruction due to diverticulitis of the colon becomes of great importance.

The case of gas and fluid in the large bowel which Dr. Rigler showed also interested me, and I think his demonstration of the ruptured cases was excellent and of great value.

We have had some trouble in cases of low bowel, large bowel obstruction, in which repeated attempts have been made to relieve the obstruction by means of enema, usually by the local physician. Sometimes in those cases air and fluid may pass the obstruction, producing an appearance which may be misleading. We would enter a plea against this practice.

H. O. BARKER, M.D. (Alexandria, La.): I would like to ask one question.

I have seen in the literature somewhere a description of the difference between small intestine obstruction and large intestine obstruction.

I want to know the distinction in cases in which only a small pattern is seen—the difference between the valvulæ conniventes —the lines of the herringbone pattern— as to whether it is small intestine or large intestine. I know you can tell when

you see quite a bit of it, but sometimes when you see a small amount you cannot tell the difference between the small intestine and the large intestine.

I would like you to go into that and tell me just how that angle comes in at that point so it is possible to tell the difference between the small intestine and the large intestine.

R. R. NEWELL, M.D. (San Francisco): I found this symposium which Dr. Rigler has arranged extremely instructive. I think I have been learning pretty fast. There are some things, however, that I do not feel very expert on at all, though I have been worrying about them for a long time before to-day.

It is easy to discern an anatomic differentiation between the large intestine and the small intestine inflated with gas. One is supposed to be able to designate which loops are large and which are small intestine and which loops are the cecum and which is the dilated sigmoid, and yet there are many cases in which I feel extremely uncertain. I do not know whether I can tease any of the essayists into admitting that he feels uncertain in some instances, too.

On account of that uncertainty, we have generally run quite quickly to the additional diagnostic means of a barium enema for cases of obstruction, whether we think the obstruction is in the small or the large intestine.

What I am driving at is this: It is quite usual in cases of distended abdomen to find that the patient, the nurse, or the orderly, under the doctor's instructions, has administered therapeutic enemas with or without results, and it does not seem to me that it is adding greatly to the patient's difficulty or distress or danger for the radiologist to give yet another enema for diagnostic purposes.

I see that Dr. Rigler did use a diagnostic enema in some of his cases and yet most of his work which he showed us was differentiation on the basis of the gas accumulated in the large intestine.

I wish he would tell me for sure whether or not he chose only those cases because he thought that that was the difficult point on which we should be instructed.

RAY A. CARTER, M.D. (Los Angeles): In relation to Dr. Rigler's paper, one might mention the rôle of acute pancreatitis in occasionally causing a severe ileus of the transverse colon.

I had an experience of finding a supposed obstruction at the splenic flexure, which at autopsy proved to be an acute pancreatitis.

We frequently see some degree of ileus of the transverse colon in these cases, but not usually to the point of confusing it with obstruction.

In relation to small intestinal obstruction, one might cite the few cases of this condition in which the distended gut is filled almost entirely with fluid and the gas present is so inconspicuous that it may be readily missed.

L. H. GARLAND, M.D. (San Francisco): The value of intestinal intubation in the diagnosis and location of intestinal obstruction appears to depend on two factors: great patience and considerable familiarity with the use of the tube. It encourages me to hear that Dr. Golden had only 30 per cent of success in his first ten attempts at intubation. We have had a somewhat similar experience at the San Francisco Hospital, and, therefore, both in the x-ray department and on the surgical wards have become somewhat disappointed with the method. However, we appreciate the fact that if we had a special team devoting most of its time to this work, the percentage of successful intubations would be much higher.

In connection with Dr. Lofstrom's case reports, I would like to know if he would again use intubation in a case such as the second to the last one which he described. This was a case of right pelvic abscess with partial ileus; it would seem to me that his plain roentgenograms indicated the diagnosis very nicely in this case and that intubation was entirely superfluous.

Finally, in the differentiation of strangulated from non-strangulated small bowel obstruction, I would like to ask Dr. Rigler if he relies greatly on the separation of loops of small bowel as seen in the plain roentgenogram. Reviewing 120 proved cases of small bowel obstruction seen during the last few years at the San Francisco Hospital (in conjunction with Dr. James Haworth), we found that in the first 24 hours the separation of loops of small bowel, by a small amount of fluid, was a highly useful sign in diagnosing early strangulation.

E. P. McNamee, M.D. (Cleveland, Ohio): I would like to ask whether you can tell by the position of the lower end of the tube what part of the small intestine that tube is in without using barium.

I was interested in the remark that you could not deflate the colon by the tube in cases in which cecostomy did deflate it, and I would like to know if there is any explanation for that.

James E. Lofstrom, M.D. (*closing*): In regard to the question of the success of intubation, I think that possibly it is just as well if I give a figure and then let Dr. Golden give his statistics. The question came up earlier in the day and we were in agreement on our estimates.

In spite of an absence of statistics at my fingertips on the exact number of cases in which we have had failure, I would roughly estimate that our success has been around 85 to 90 per cent.

I believe that the reason for this high figure has been an avid interest in the subject in the Detroit Receiving Hospital, on the part of Dr. Johnston and his associates, particularly among whom is Dr. Noer, who spends a vast amount of time personally with these patients.

Persistence is the keynote to success, and although we have had cases in which it has been absolutely impossible to get the tube down, in the majority we are repaid with success for tenacity and strict attention to a few of the details which Dr. Golden and I mentioned.

There are a good many tricks with which one becomes acquainted as experience with intubation is gained. However, the surgical departments carry out most of the intubation themselves—the introduction of the tube—and they have adequate help. As Dr. Golden mentioned, he relies on the nurse who has been trained. I think that is advisable; having one or two persons who have an interest in intubation and a willingness to work assigned to the particular duty.

In regard to Dr. Garland's question about the case of the pelvic abscess, I think that any patient who shows a distention of the bowel and signs of acute intestinal obstruction should be intubated, and I think that it would be done again. The question of how soon to do the colpotomy to drain that abscess may be debatable, but I think that intubation should be carried out in the interim, even though colpotomy is done.

One other point which I wanted to make was in regard to the case which Dr. Rigler showed of the obstruction in the ascending colon in which there was a localized distention of the cecum. I believe in that case that it would be possible to intubate. There was some distention of the small bowel. Why would it not be possible to intubate with the long tube and let it go on into the cecum? I do not see any reason in the world why it would not decompress the cecum, giving a valve which would afford protection against perforation. Of course, when cecostomy cannot be done, as in the one case in which the patient would not permit operation, I think a tube might be of some value.

Ross Golden, M.D. (*closing*): I am sorry that I cannot give you the exact figures concerning failure in intubation of the small intestine. These details will be given in an article by Leigh, Nelson, and Swenson soon to appear in the *Annals of Surgery*.

I have the impression that most of the

failures occurred in the first ten cases and that since then there have been at the most only one or two failures.

Just recently, Dr. Swenson remarked that he almost gave up on a case after two days on account, apparently, of an unusually spastic antrum, but after two days of effort the tube slipped into the duodenum.

The success at the Presbyterian Hospital in the passage of the Miller-Abbott tube has depended entirely on the personal efforts of Dr. Leigh and Dr. Swenson. Dr. Leigh, with Dr. Swenson's aid, worked up this technic and then a nurse was assigned to work with him. He trained her in the various processes necessary to get the tube through the pylorus, and her only duty now is to take care of the Miller-Abbott tube procedure and to keep the tubes cleaned and in order.

As I mentioned before, one of the most important things in the technic is the deflation of the stomach and the repeated gastric lavages through the Miller-Abbott tube. This makes the patient feel so much better that he is glad to continue cooperation.

Too much of the tube must not be inserted at once. If too much tube is pushed in, some of it will regurgitate back or it may coil up. In one case it even tied itself into a knot in the stomach. The position of the tube in the intestine can be determined, in the vast majority of cases, with some accuracy by x-ray examination without barium injection, but occasionally the injection of opaque material is necessary. For example, the tube tip may be in the lower ileum and superimposed upon the cecum so that one cannot be sure whether or not it is in the cecum until barium is injected.

As to the failure to deflate the colon, like Dr. Lofstrom I could not understand why the tube might not deflate the large intestine as well as the small intestine. Dr. Leigh has emphasized the fact that in all of these cases he has never seen an instance of regurgitation of gas from the large intestine into the small intestine. If the tube gets into the cecum, the semifluid material there is sufficiently thick so that it is impossible to suck it out through the small holes in the tube. Our experience has shown very definitely that the Miller-Abbott tube does not suffice to deflate the large intestine although it works perfectly in the small intestine. A cecostomy must be done to deflate the large intestine.

In conclusion, I would like to emphasize the thing that Dr. Wangensteen[1] mentioned; that is, the importance of cordial, sympathetic co-operation between the members of the department of radiology and the members of the department of surgery in handling these cases.

LEO G. RIGLER, M.D. (*closing*): I seem to have most of the questions to answer.

I was interested in Dr. Holmes' statement as to the question of syphilis producing this type of spastic colon. Of the two cases which I presented, one was a post-pneumonic patient who had had a pneumonia several weeks before. She came to autopsy and there was no evidence of syphilis or anything else we could find to explain this satisfactorily.

In the other case, the second I showed, the patient was operated upon. She was a neurasthenic; maybe that had something to do with it. She had had repeated attacks of what, to a good clinician, appeared to be acute obstruction and which inflated the colon as we saw in the films, yet nothing organic was ever found. She certainly did not have syphilis; I am sure of that. As to what she did have, I am not at all certain.

I agree entirely with Dr. Holmes about diverticulitis producing obstruction. One case I showed was a case of diverticulitis and it is an important thing to bear in mind.

In answer to Dr. Barker's question, which requires a good deal of time, I may say this: We attempt to make a sharp distinction between the small and the large bowel on the flat films. This is done first by the observations of the position of the

[1] Dr. Wangensteen's paper will be published in the next issue.

loops of bowel. We know that, in general, the colon tends to follow around the periphery of the abdomen, while the small bowel tends to arrange itself in the middle.

Second, the character of the folds is distinctly helpful. Dr. Wangensteen showed a slide, which we use a good deal, which points out, also, that the distinction on the basis of folds alone is not easy, but, on the contrary, is exceedingly difficult to make. The arrangement of the loops is extremely significant.

The colon can be traced out in a sort of up-and-down, redundant fashion.

Now in a case in which there are small amounts of gas, I do not think the problem is terribly serious because there is rarely obstruction of the colon with only a small amount of gas. There is always gas in the colon and an obstruction of the colon would scarcely be attended by the presence of but a small amount of gas. If we can distinguish a few distinct loops with gas within them, one over the other, then it is almost certain that it is the small bowel with which we are dealing, not the colon.

Bearing in mind all these factors, the fact remains (as I think I tried to show in some of the cases I demonstrated here) that from the simple film of the abdomen alone the distinction is not possible in all cases.

I wanted to emphasize the fact that we can use the simple film of the abdomen in acute obstruction of the colon as well as in the acute obstruction of the small bowel and obtain considerable help. We have no objection at all to the use of a barium enema. I meant to say that in certain cases it is extremely difficult to use and often one can arrive at the conclusion he desires without the use of the enema.

In cases in which there is doubt, we go ahead and do a barium enema without hesitation. If there is still doubt, we attempt to deflate the individual through the duodenal or Miller-Abbott tube and that, in itself, is a highly successful thing in making the distinction between small bowel loops and those in the large bowel.

I am glad Dr. Carter brought up the point about the distention of the colon from pancreatitis. There is no doubt that it does occasionally produce a distinct ileus or distention of the transverse colon. Ordinarily, however, in consideration of cases such as I showed, the thought that there is a lesion of the colon is already in the mind of the clinician and the problem that we are confronted with is to help confirm that thought, as it were, and follow it up with further and more accurate observations; yet I think it is conceivable that acute pancreatitis producing distention of the transverse colon might lead us astray in the direction of making a diagnosis of tumor.

Dr. Garland's question about strangulation was an interesting one. We have for many years (I think Laurell, of Upsala, was the first to describe this) paid considerable attention—and we do all the time—to the amount of separation between the loops of small bowel when they are distended, largely with a view to trying to diagnose peritonitis, and I think I showed one slide of that kind. I think it is quite true that in cases of strangulation this may be a sign which appears at an early stage, due to the fluid, and I agree with him entirely.

I want to make one more comment, stimulated by the two cases of gallstone obstruction which Dr. Lofstrom showed. Given a patient who has symptoms suggestive of intestinal obstruction but in whom the symptoms are rather intermittent and confusing (as is almost invariably the case in gallstone obstruction), careful examination, either of the ordinary film of the abdomen as a whole or of the local film made over the liver in the gall-bladder region, should be made to determine if there are evidences of gas in the bile ducts.

Given a patient, then, who has some distention of the small bowel and who also has gas in the bile ducts, the final diagnosis of gallstone obstruction can be made with a great deal of certainty without seeing the gallstone at all. We have had that experience and I think it is worth while remembering in that type of case.

CLEAVAGE DELAY IN *ARBACIA PUNCTULATA* EGGS IRRADIATED WHILE CLOSELY PACKED IN CAPILLARY TUBES

By IRVING COHEN, Marine Biological Laboratory, *Woods Hole, Massachusetts*

FROM the work of Henshaw (1932) and others, it is known that x-rays administered to *Arbacia punctulata* eggs prior to fertilization cause a delay in the occurrence of cleavage.

In the Summer of 1938, it was suggested to the writer that if *Arbacia punctulata* eggs were irradiated while closely packed in capillary tubes by hand centrifuging, the cleavage delay produced by a given dose of x-rays might be less than in the case in which the eggs are irradiated in large amounts of sea water.

This prediction was based on an extension of Failla's theory of the biologic action of ionizing radiations (1937). In this he postulates that the biologic effect is enhanced when, through diffusion, circulation, or otherwise, the ion concentration in the intercellular medium is decreased. This is not directly applicable to the present experiment. However, Failla has suggested that, owing to the greater complexity of the molecules within the egg, the increase in ion concentration resulting from x-rays might be relatively greater in the cytoplasm than in the surrounding sea water. Therefore, the radiation might produce an initial ionic imbalance across the cell boundary and this is assumed to enhance the radiation effect. On the other hand, when the eggs are closely packed in capillary tubes, there is practically no sea water surrounding the cells so that the ionic imbalance, and hence the radiation effect, might be expected to be less.

The experimental results show that considerably less delay in cleavage is produced in the eggs irradiated in the capillary tubes.

Preliminary experiments were carried out in the Summer of 1938 and the work was continued and completed during the Summer of 1939. The general technic worked out by Henshaw has been followed throughout the experiment.

Eggs from one female were divided into lots to provide: (1) control samples kept and inseminated in syracuse dishes; (2) samples irradiated in celluloid "pill boxes" with considerable sea water surrounding the eggs and then kept and inseminated in syracuse dishes; (3) samples packed into fine capillary glass tubes (0.6 mm. bore) by hand centrifuging, irradiated in 1/4 in. sections of the capillary, immersed in the same amount of sea water as sample (2), then kept and inseminated in syracuse dishes; (4) control samples for the above which were subjected to the same manipulations except that no x-rays were administered.

It should be noted that the eggs were not generally left in the capillaries for a period longer than twenty minutes. This treatment did not prove to be deleterious to the eggs, although a slight effect in the delay of cleavage in the non-irradiated control tubes was often observed. This delay was always taken into account in the interpretation of the data.

The two sets of unfertilized eggs were irradiated simultaneously. The x-ray equipment was a dual tube, self-rectifying machine available at the Marine Biological Laboratory. This provides two cross-firing beams of x-rays of high intensity and large doses can be administered in a few minutes' exposure. Two qualities of radiation were employed: (1) The secondary voltage was kept at approximately 200 kv. and the current passing through each tube was 25 ma. The output intensity, measured in air at the point of treatment after filtration by the heavy glass tube wall and 5 mm. bakelite of the tube shield, was approximately 7,400 r/min. at a target–specimen distance of 9.5 cm. (2) Secondary voltage was kept at 100 kv. and 30 ma. through each tube, delivering approximately 3,300 r/min. at the same target–specimen distance.

The material was placed in the center

of the field and irradiated for three minutes, using the 200 kv. x-rays and for ten minutes using the 100 kv. x-rays, delivering in one case a dose in the neighborhood of 22,000 r, and in the other approximately 33,000 r. The material was immediately removed after treatment and arranged in the manner described above so that the radiation effect could be observed and recorded.

The criterion of effect was the delay in the occurrence of first cleavage. The time elapsed between insemination and the time when 50 per cent of the eggs have completed their first division was called "cleavage time." This value minus the cleavage time of the non-irradiated controls was the delay in cleavage.

The results using the high and low voltage x-rays showed that the eggs irradiated in the glass capillaries were more radioresistant or showed less radiation effect than the eggs irradiated with the surrounding sea water.

The possibility that secondary radiation produced by atoms of high atomic weight present in the sea water might be responsible for the difference noticed was investigated by using the low voltage x-rays. The results showed the same magnitude of effect using both qualities of radiation therefore, eliminating the factor of secondary radiation.

TABLE I

Experiment No.	Percentage Delay in Dishes	Percentage Delay in Capillaries	Dishes/cap.
1	67	72	0.93
2	156	123	1.27
3	162	125	1.30
4	130	92	1.41
5	195	79	2.46
6	158	76	2.08
7	85	68	1.25
8	120	90	1.33
9	191	119	1.60
10[1]	249	219	1.14
11[1]	190	160	1.19
12[1]	236	93	2.54
13	190	125	1.52
14	146	91	1.60
15	196	113	1.73
16[1]	264	210	1.26
17[1]	275	193	1.42
18	196	132	1.49
Average	178.1	121.1	1.53

[1] Low voltage experiments.

It should be noted that while the experimental results confirm Dr. Failla's prediction, it does not follow that the suggested explanation is necessarily correct. (This point is fully appreciated by Failla who has followed the work with interest.) There are, of course, other possible explanations which should be investigated. For instance, Anderson (1939) has shown that less cleavage delay is obtained when *Arbacia* eggs are irradiated in the absence of oxygen. If diffusion of oxygen into the capillary tubes of the experiments reported here is very slow, the observed results may well be due to this factor. It is interesting to note that on the assumption that a deleterious agent is produced within the eggs by the x-rays, the observed effect should be greater when the eggs are irradiated in the capillary tubes; remembering in this connection that the hypothetical injurious agent must be able to diffuse out of the eggs to account for the marked recovery observed by Henshaw and others. Obviously the diffusion process would be much slower in the case of the closely packed eggs.

Table I is a summary of the experimental data. The values are given in percentage of delay which were obtained by dividing the cleavage delay of the irradiated eggs by the cleavage periods of the controls.

Whatever the correct explanation may be, the results constitute an interesting example of the dependence of radiosensitivity on cell environment.

The author wishes to express his appreciation to Dr. G. Failla, of the Memorial Hospital, New York City, and to Dr. P. S. Henshaw, of the National Cancer Institute, Bethesda, Maryland, for their interest and helpful suggestions in connection with this work.

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THE GOLDFISH AS A NEW BIOLOGIC TEST OBJECT IN EXPERIMENTAL RADIATION THERAPY[1, 2]

By FRIEDRICH ELLINGER, M.D., D.M.Sc., *New York City*

From the Radiotherapy Department, Montefiore Hospital for Chronic Diseases

THE problem of clinical evaluation of the action of x-rays has been approached by different means: *Biologic methods* permit us to express qualitatively as well as quantitatively the effects of radiation; *Physical methods* enable us to calculate in r units the total dose of x- or gamma radiation delivered to a certain volume of tissue.

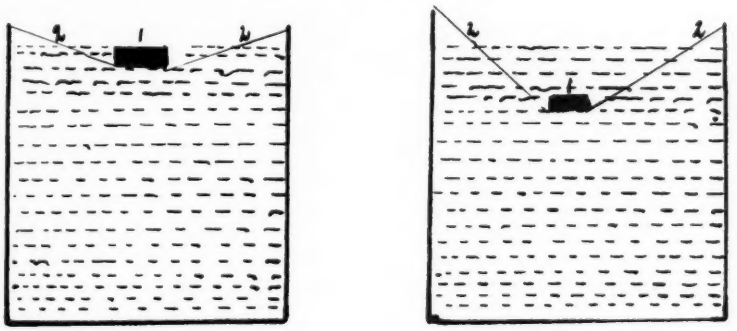
The task of experimental radiation therapy consists in the correlation of physical doses with biologic effects. Scientists in all parts of the world have contributed considerably to the solution of this problem.

Interest has been focussed anew on this problem recently, since, in the development of supervoltage x-ray therapy, some disagreement between biologic observations and measurements by means of ionization chambers has been discovered (1, 3, 4, 8, 10, 15). To evaluate the action of x-rays of different wave lengths, it appeared worth while to try a biologic test object not hitherto used for this purpose, and in the paper to follow our experience with its use has been reported.[3]

Because depth dose measurements are important and since the water phantom is commonly used for such measurements, the use of fish whose habitat is water seemed logical, and the goldfish (*Carassius auratus*)[4] was chosen.

The use of goldfish offers the following advantages:

METHOD OF IRRADIATION



A. Surface, or Zero, Position.—Petri dish (1) resting on a layer of gauze (2) suspended flush with the surface of the water in the phantom.

B. Depth.—Petri dish (1) submerged. Depth measured from the surface of the water in the phantom to the upper margin of the Petri dish.

Fig. 1.

[1] Presented before the New York Roentgen Ray Society, May 20, 1940.

[2] Aided by a grant from the Emergency Committee, in Aid of Displaced Foreign Physicians.

[3] A preliminary report has been published in Proc. Soc. Exper. Biol. and Med., **41**, 527, 1939.

[4] Goldfish have been used successfully in the dosimetry of chemicals in experimental pharmacology (1, 5, 9).

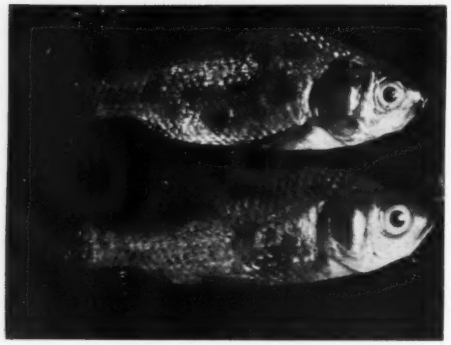


Fig. 2.

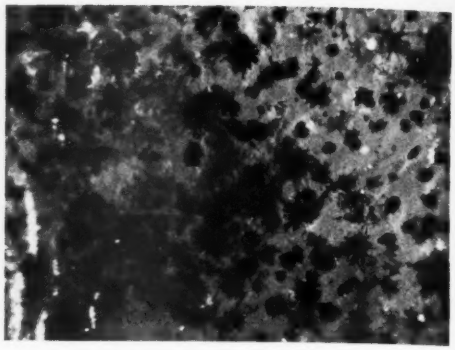
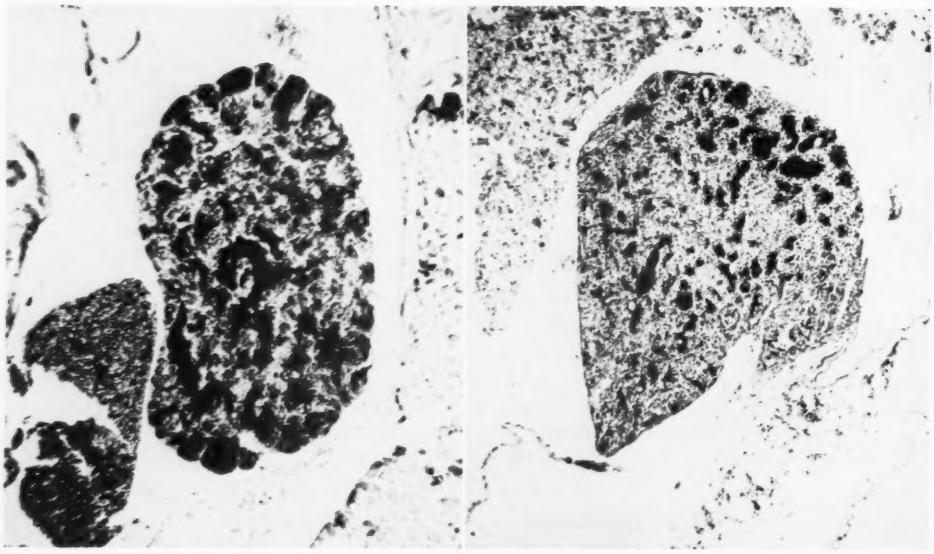


Fig. 3. (Enlarged 80 ×.)



Control (spleen). Irradiated (spleen).

Fig. 4.

1. No covering material is necessary, which may influence the effects of radiation.

2. The difficulty of providing sufficient oxygen for respiration in the depths is overcome.

3. Goldfish of small size permit the simultaneous irradiation of large numbers of individuals, thus avoiding the danger of error in instances in which too few individuals are used.

4. In spite of small size, their rate of growth is very slow. This makes them especially suitable for study of the time-intensity factor.

5. They permit an approach to the problem of "volume dose" on adult individuals of the same kind varying in size 1:100 and more.

6. Goldfish are available the year around; they are cheap and their care is easy.

Technics. The radiation factors were: 200 kv., 30 ma. (mechanical rectification);

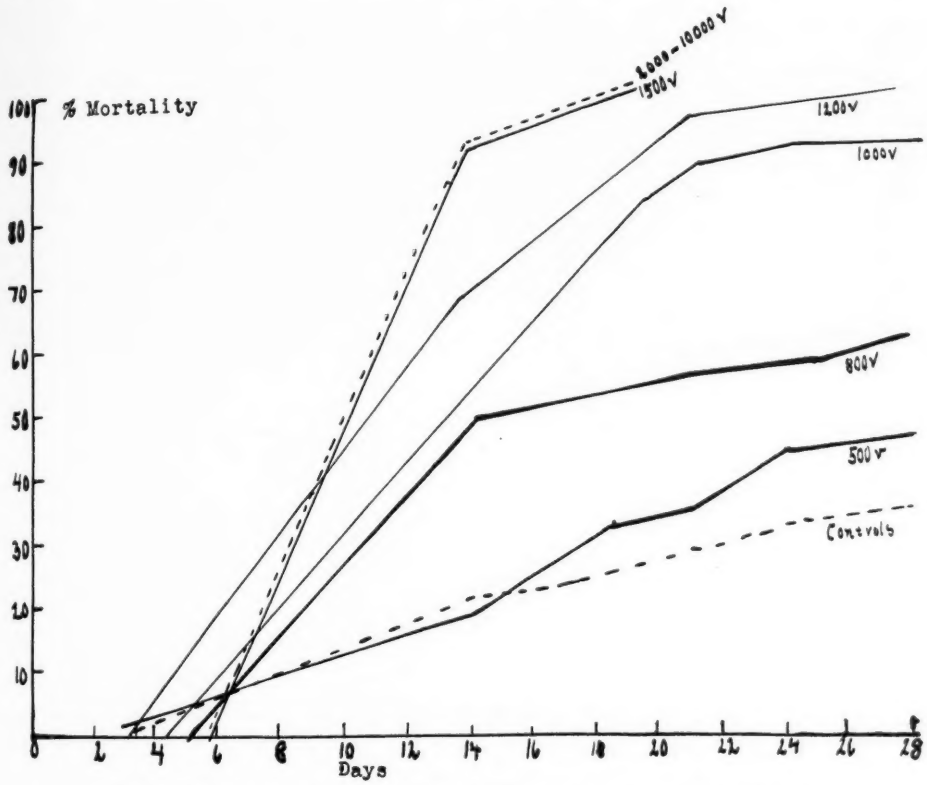


Fig. 5. Lethal effect of x-rays of H.V.L. 0.233 mm. Cu. Doses: 500 to 10,000 r.

filter (*a*) zero, H.V.L. 6 mm. Al, corresponding to 0.233 mm. Cu (intensity, 230–172 r/min.); (*b*) 0.5 mm. Cu and 1 mm. Al, H.V.L. 1 mm. Cu (intensity, 48 r/min.).

The distance was always 50 cm. (target–surface of the water), and the field size 15 × 15 cm. The doses, ranging from 500 to 10,000 r (measured in air), have been given in one session. A total of more than 2,000 goldfish were used in these experiments, 500 of which served as unirradiated controls

For each exposure 12 fish were placed in an open Petri dish, 15 cm. in diameter, covered with a single layer of gauze fixed by an elastic. In the surface position, as shown in Figure 1-*A* (zero position of the experiments), the dish (1) rested on a layer of gauze, suspended flush with the surface of the water in the phantom. For the study of the action in the depths the dish was submerged to the desired depth, measured from the surface of the water in the phantom to the upper margin of the Petri dish (Fig. 1-*B*). The water phantom measured 32 × 32 × 32 cm., thus permitting the maximum back-scatter (11). Ionization measurements with a Victoreen chamber showed an increase in back-scatter from the Petri dish of 3 per cent for H.V.L. 0.233 mm. Cu and of 7 per cent for H.V.L. 1.0 mm. Cu.

After irradiation, each series and its control were placed in simple aquaria without circulating water or artificial oxygen supply, containing 7,000 c.c. of water at a temperature of from 19 to 24° C. In the beginning 12 fish, later on 6, were placed in each aquarium containing plants (*Cabomba* or *Elodea canadensis*).

General Appearance of Irradiated Goldfish.—Irradiated goldfish revealed three phenomena, as follows:

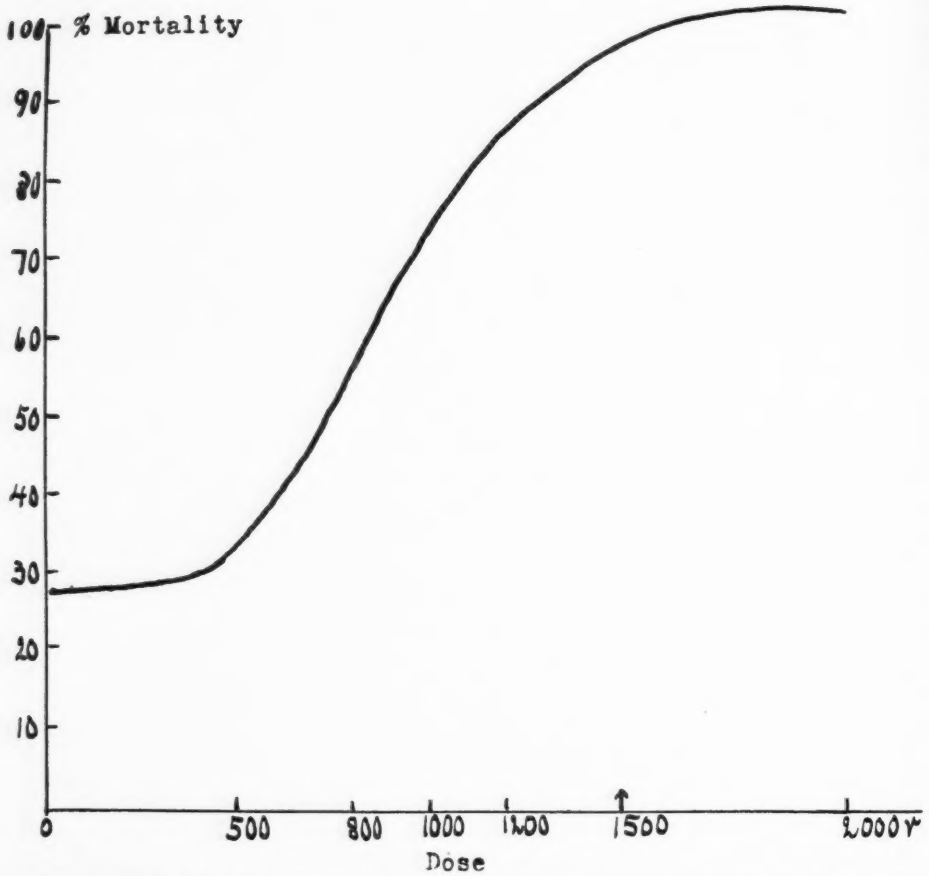


Fig. 6. Lethal effect of x-rays of H.V.L. 0.233 mm. Cu for the eighteenth day. Doses: 500–10,000 r. Total: 774 goldfish. The graph shows the typical S-shaped mortality curve. Mortality increases up to 1,500 r. This dose represents the minimum lethal dose which kills all fish within 19 days.

1. Latent period: No changes as a rule were noted during the first week following irradiation.

2. Death: In the second or third week (depending upon the dosage) the fish became less active, stopped eating, developed dyspnea, and finally died.

3. Pigmentation: In some instances, in the second or third week, a brownish-black pigmentation appeared on both sides of the trunk (Fig. 2, *upper fish*). Microscopic examination revealed a spread of astrospherical chromatophores (Fig. 3).

X-ray pigmentation of goldfish has already been described by Dr. G. M. Smith, of Yale University, in 1932 (12, 13). Our results, therefore, support the previous data.

Postmortem Examinations.—Through the courtesy of Dr. D. Perla, of the Division of Laboratories, the microscopic examination of the organs of some irradiated fish was possible. The postmortem examination revealed: Atrophy and shrinkage of all lymphoid tissue and pycnosis of surviving lymphocytes; increase in fibrous tissue. In the spleen there was complete disappearance of lymphoid elements and marked proliferation of macrophages. The severity of these changes were dependent upon the x-ray dosage. Figure 4 shows sections of a normal and an irradiated spleen.

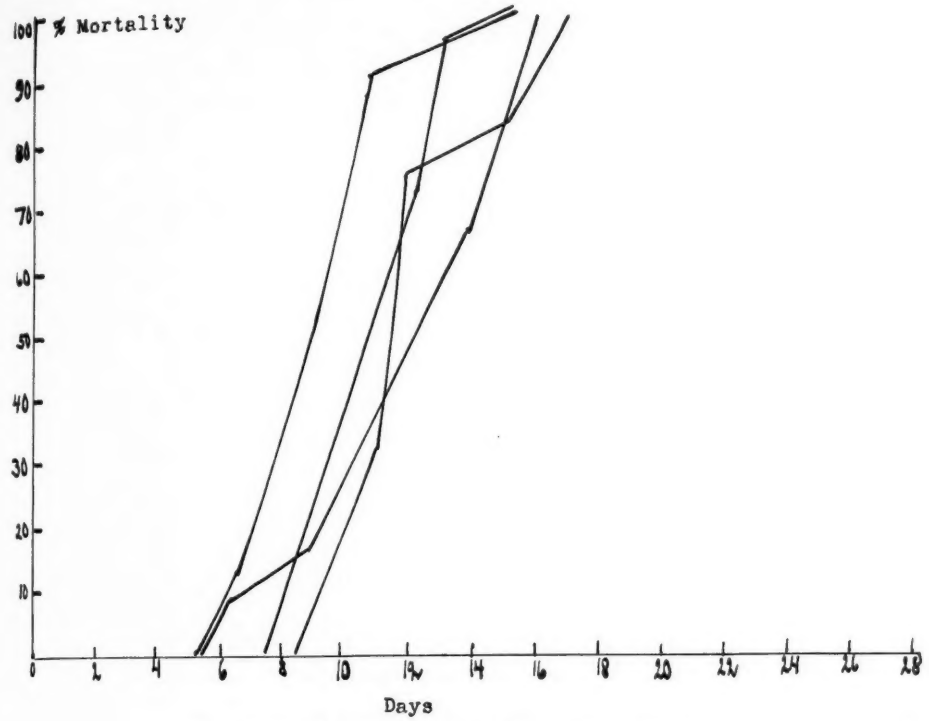


Fig. 7. Consistency of the lethal effect. Dose: 2,000 r.

The Lethal Effect as Test for the Biologic Action of X-rays.—An ideal biologic test object should permit the reading off of a number of reactions with accuracy (6, 8). Among the three phenomena which irradiated fish revealed, death and pigmentation could be used for this purpose. While the latter did not occur in all irradiated fish, the lethal effect appeared to meet the prerequisites of an ideal test. Death is easily observable, and this phenomenon permits the setting up of mortality (survival) curves, which make it easy to compare the action of different types of radiation. The problem was, whether, with increasing doses, the percentage of killed fish would increase accordingly. To answer this question, doses ranging from 500 to 10,000 r have been examined on 774 fish.

Figure 5 shows how, by increasing the dose of x-rays of H.V.L. 0.233 mm. Cu, the mortality increases up to 1,500 r. Doses more than 1,500 r do not affect the shape of the curves. Therefore, 1,500 r represents the minimum lethal dose which kills all goldfish within 19 days. This figure is very close to data for cells of mammals, *e.g.*, Mouse Sarcoma 180 (14). The graph shows, furthermore, that under our experimental conditions the mortality of unirradiated fish reaches an average value of 35 per cent at the end of the fourth week. Whether or not 500 r have already a lethal effect, may, therefore, be considered as questionable.

The curve in Figure 6 represents the mortality for the eighteenth day after irradiation plotted against dosage. The graph shows the typical *S*-shaped mortality curve. This is well known as the "survival curve" from experiments with single cells (2). Exponential mortality or survival curves are of considerable theoretical

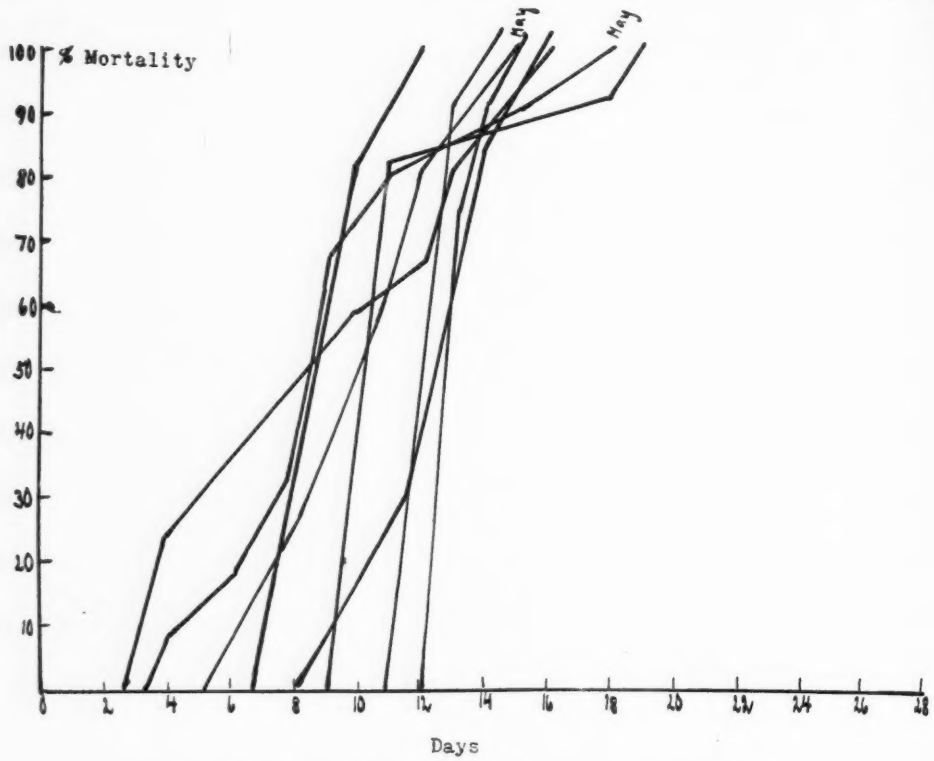


Fig. 8. Consistency of the lethal effect the year round. Dose: 1,500 r.

TABLE I.—RELATION BETWEEN BODY-WEIGHT AND VOLUME OF GOLDFISH

Weight (g.)	Volume (c.c. of water)
4.2	4.5
4.1	4.4
3.5	3.8
2.7	3.0
2.6	2.7
2.6	2.8
2.5	2.5
2.4	2.5
2.1	2.5
2.0	2.3
1.9	2.0
1.7	1.8
1.6	1.7
1.5	1.9
1.3	1.4
1.0	1.1
1.0	1.0
0.9	1.1
0.8	0.9
0.5	0.5

importance. They will not be considered here, as they are beyond the scope of this paper.

FACTORS WHICH MAY INFLUENCE THE LETHAL EFFECT

(1) *Individual and Seasonal Variation of Radiosensitivity.*—Since it is another requirement for an ideal biologic test object that its average radiosensitivity shall be sufficiently constant, the question arises, how far individual and seasonal variations of the radiosensitivity of goldfish may influence the lethal effect.

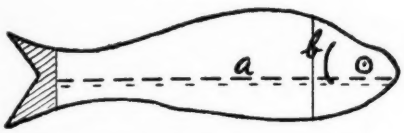
Figure 7 demonstrates the constancy of the lethal effect in four consecutive exposures to 2,000 r during one month. Figure 8 shows observations of the lethal effect after exposure to the minimum lethal dose of 1,500 r. In spite of the fact that the observation time was scattered over the period February to December, in five out of eight series all fish died about the fifteenth day.

As can be seen, the study of the com-

TABLE II

Series 17A	3.0	1.0	3.2	2.2	1.7	2.5	1.9	3.0	2.7	1.7	2.2	1.4
Series 53C	4.0	3.0	3.2	2.5	2.6	6.8	2.7	6.5	3.2	2.7	3.5	1.9
Series 22H	0.95	2.3	1.9	2.5	1.9	1.2	2.2	1.9	3.7	1.5	2.5	1.9

TABLE III



Weight (g.)	a, Length (cm.)	b, Width (cm.)	Thickness (cm.)
7.1	6.3	1.9	1.3
6.8	6.3	2.0	1.0
6.5	6.2	1.7	0.9
6.3	6.1	1.7	1.1
5.8	5.8	1.8	1.0
5.2	5.9	1.9	1.0
4.2	4.7	1.8	0.9
4.1	5.2	1.5	0.9
3.5	4.5	1.5	0.7
3.2	4.7	1.3	0.7
3.0	4.5	1.2	0.6
2.7	4.7	1.2	0.5
2.6	4.2	1.5	0.6
2.5	4.5	1.3	0.5
2.3	4.1	1.4	0.6
2.2	4.1	1.2	0.6
2.1	3.9	1.3	0.6
2.0	4.0	1.3	0.6
1.9	3.9	1.2	0.5
1.7	3.9	1.0	0.5
1.6	4.0	1.1	0.5
1.5	4.0	1.1	0.5
1.4	3.6	0.9	0.4
1.3	3.6	0.9	0.4
1.1	3.5	0.7	0.4
1.0	3.4	0.9	0.5
1.0	3.2	0.9	0.5
0.8	2.8	0.9	0.4

bined influence of individual and seasonal variation of radiosensitivity revealed a sufficiently constant average radiosensitivity of the goldfish the year around. We have the impression that there are some seasonal variations of radiosensitivity which seem to increase slightly in spring and summer. But apparently the seasonal variation does not exceed the individual variation, since in May there have been found (Fig. 8) extremely long and short periods for the completion of the lethal action of x-rays.

(2) *Influence of the Fish's Volume.*—The use of commercial goldfish implies certain differences in their size (volume).

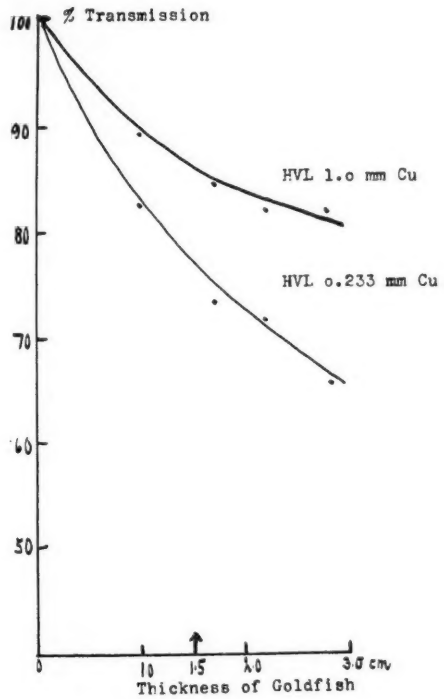


Fig. 9. Absorption of x-rays in goldfish. Transmission curves show that in the range 1:2 cm. the difference in absorption is ±5 per cent for the average width of 1.5 cm. Differences in width seem to be unlikely to play any part in the lethal action of x-rays within the observed range.

TABLE IV.—IONIZATION MEASUREMENTS WITH VICTOREEN CONDENSOR DOSIMETER

Factors: 200 kv., 30 ma.
Field: 15 × 15 cm.
Distance: 50 cm.
Filter:

	(*a*) zero, H.V.L. 0.233 mm. Cu	(*b*) 0.5 mm. Cu and 1.0 mm. Al, H.V.L. 1.0 mm. Cu
In air	172 r/min.	48 r/min.
Surface	236 r/min.	68 r/min.
Zero position of the experiment (see Fig. 1)	185 r/min.	60 r/min.
Ten cm. depth (see Fig. 1)	41 r/min.	20.5 r/min.
Depth dose	22 per cent	34 per cent

A study of the so-called "volume-dose" seemed necessary because of the well known clinical importance of the irradiated volume for the radiation effect. The relation between the body weight

of the fish and their volume (measured by displacement of water) was examined, as a first step toward the solution of this problem. The volume of the fish is sufficiently determined by their body weight in the range 1:8 (0.5 to 4.2 g.), as may be seen in Table I.

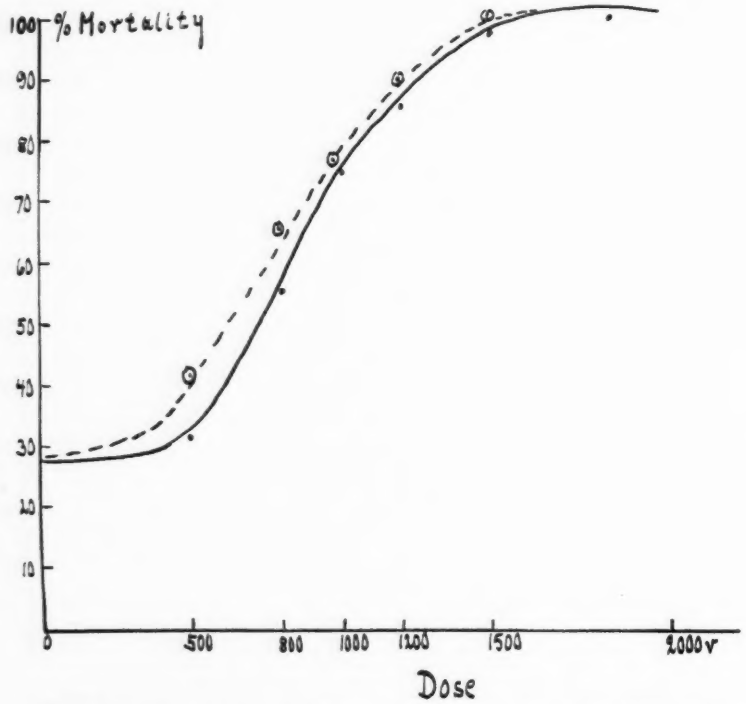


Fig. 10 Wave length and lethal effect. Mortality curves for the eighteenth day. Dotted line, x-rays of H.V.L. 1.0 mm. Cu; solid line, x-rays of H.V.L. 0.233 mm. Cu. No difference in the effect.

Table II shows three sets of experiments in which the weight of fishes has been recorded in the order in which they died. It will be noted that there is no relation between the body weight (volume) and the order in which the fish died. In the one series the smallest fish, in another one the largest fish, was the first to die. Whether this holds good also for fish of larger size will be a matter of further studies. Within the examined range of size, however, there seems to be no objection in using fish of varying volume.

(3) *Influence of the Width.*—Due to varying absorption, width is the most likely cause of variations in the lethal effect (from the same or from different wave lengths), as the irradiation was always applied in the dorso-ventral position. In Table III there are listed weight, length, width, and thickness of goldfish as used in these experiments, to clarify the importance of this factor: while the weight may differ in the range 1:9 (from 0.8 to 7.1 g.), the width only increases in the range 1:2 (from 0.9 to 2.0 cm.).

Figure 9 shows some transmission curves gathered from measurements on dead fish with a Victoreen ionization chamber. The measurements were made in cooperation with Miss L. Jacobson, physicist of our department. It will be noted that within individual curves, the absorption within a thickness of from 1 to 2 cm. shows only a small variation (about ±5 per cent).

The same is found to be true when the two curves of the different types of radiation are compared with another. From the above mentioned figures the conclusion may be drawn that differences in width seem unlikely to play any part in the lethal action of x-rays within the observed range.

(4) *Influence of Wave Lengths.*—Figure 10 shows the mortality curves for x-rays of H.V.L. 0.233 and 1 mm. Cu, respectively. As can be seen, there is no difference in the effect of these two types of radiation. Within the observed range, there is no wave length dependency of the lethal effect. Whether or not this holds good also for radiations of shorter or longer wave lengths will be the subject of studies now in progress.

(5) *Influence of Intensity of Radiation.*—Figure 10 also demonstrates that although the intensities used varied in the proportion of 1:4 (from 48 r/min. to 230 r/min.) with the different wave lengths tested, the conclusion may be drawn that varying intensities within the observed range play no part.

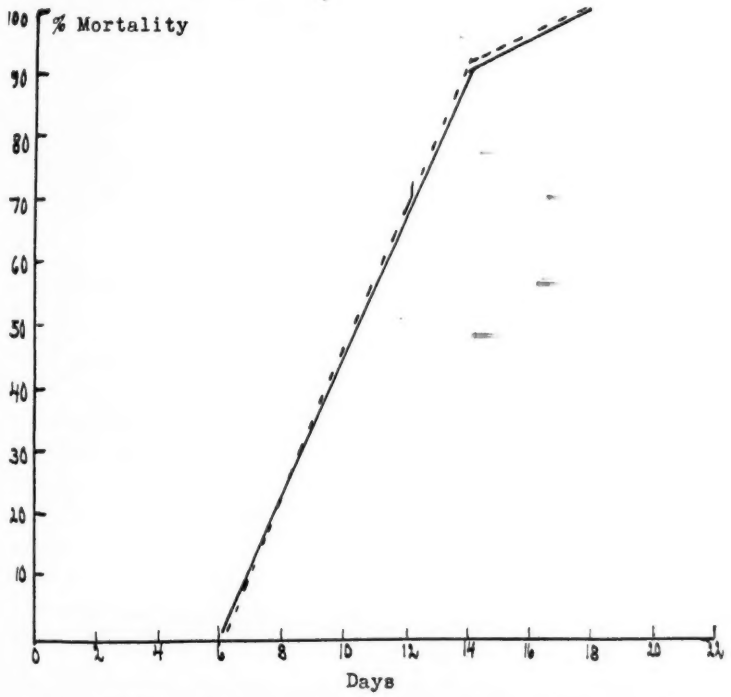


Fig. 11. Solid line, lethal effect of 9,000 r, measured in air, given to fish in 10 cm. depth of the water phantom; dotted line, lethal effect of 2,000 r, measured in air, given to fish on the surface of the water phantom. Radiation: H.V.L. 0.233 mm. Cu.

SUITABILITY OF GOLDFISH TEST FOR STUDY OF ACTION OF X-RAYS IN DEPTHS OF WATER PHANTOM

The figures reported so far have furnished some basic information concerning the suitability of goldfish as a test material for the evaluation (dosimetry) of surface effects of x-rays. Some preliminary data concerning the suitability for the evaluation of the action of x-rays in the depths of the water phantom may be added. The basis for these studies was

ionization measurements with a Victoreen condensor dosimeter, conducted in cooperation with Miss L. Jacobson. Table IV shows that under our experimental conditions a depth dose of 22 per cent and 34 per cent of a radiation of H.V.L. 0.233 and 1 mm. Cu, respectively, was achieved in 10 cm. depth of the water phantom.

Based on these figures a dose of 9,000 r (H.V.L. 0.233 mm. Cu), measured in air, was given to the fish fixed in a depth of 10 cm. in the water phantom. According to the ionization measurements such a dose has to be considered as equal in action to 1,880 (2,000) r when given to fish in the surface position of the water phantom. This should be a lethal dose.

Figure 11 shows the curve of this dose based on the observation of 84 fish. For comparison, the curve of the lethal action of a dose of 2,000 r on the surface (dotted line) is included. As can be seen, there is complete agreement of both curves. Figure 12 shows how, with decreasing doses given to fish in 10 cm. depth of the water phantom, the lethal effect is decreasing too.

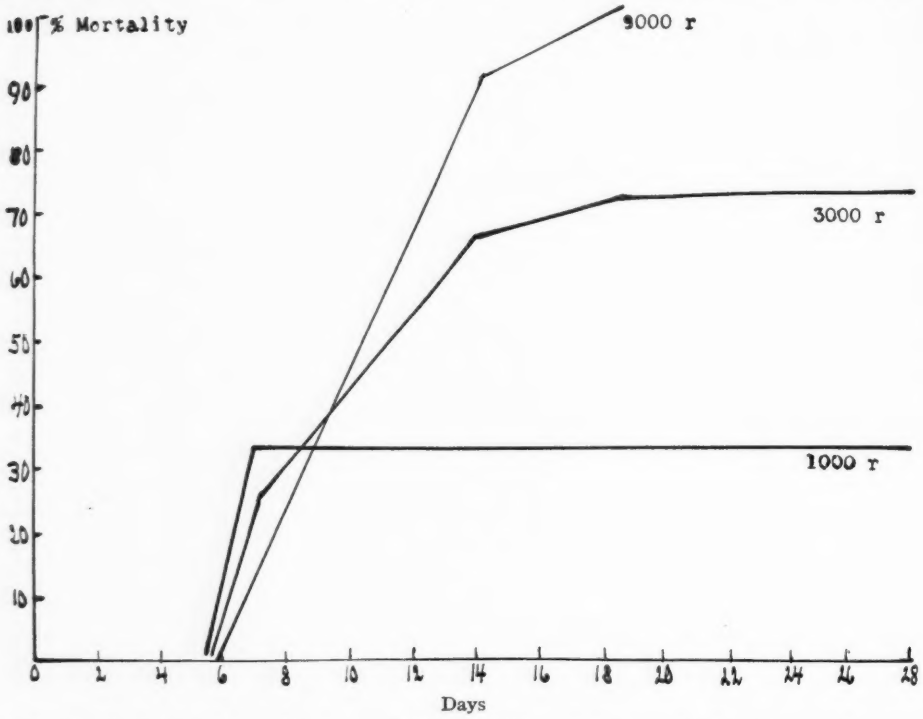


Fig. 12. Evaluation of the action of x-rays of H.V.L. 0.233 mm. Cu in 10 cm. depth of the water phantom.

Figure 13 finally demonstrates the effect of a dose of 3,000 r measured in air for a radiation of H.V.L. 0.233 and 1 mm. Cu, respectively, when given to fish at 10 cm. depth in the water phantom. Corresponding to the above mentioned ionization measurements, this graph shows the greater lethal effect of the radiation, *A*, with the higher depth dose.

These preliminary data seem to demonstrate the suitability of goldfish for the evaluation of the action of x-rays in the depths of the water phantom. The quantitative aspect of this problem will be considered further, after studies which are now in progress.

SUMMARY AND CONCLUSIONS

(1) The goldfish test seems to be suit-

able for the study of the action of x-rays on the surface and in the depth.

(2) The goldfish test complies with most of the requirements for an ideal biologic test object for the following reasons:

(*a*) It is available at any time, inexpensive, and the care of the goldfish is easy.

(*b*) Its radiosensitivity is very close to that of cells of mammals.

(*c*) It permits the reading off of different stages of reaction with accuracy and without difficulty. It permits the setting up of mortality curves which make it easy to compare the action of different types of radiation.

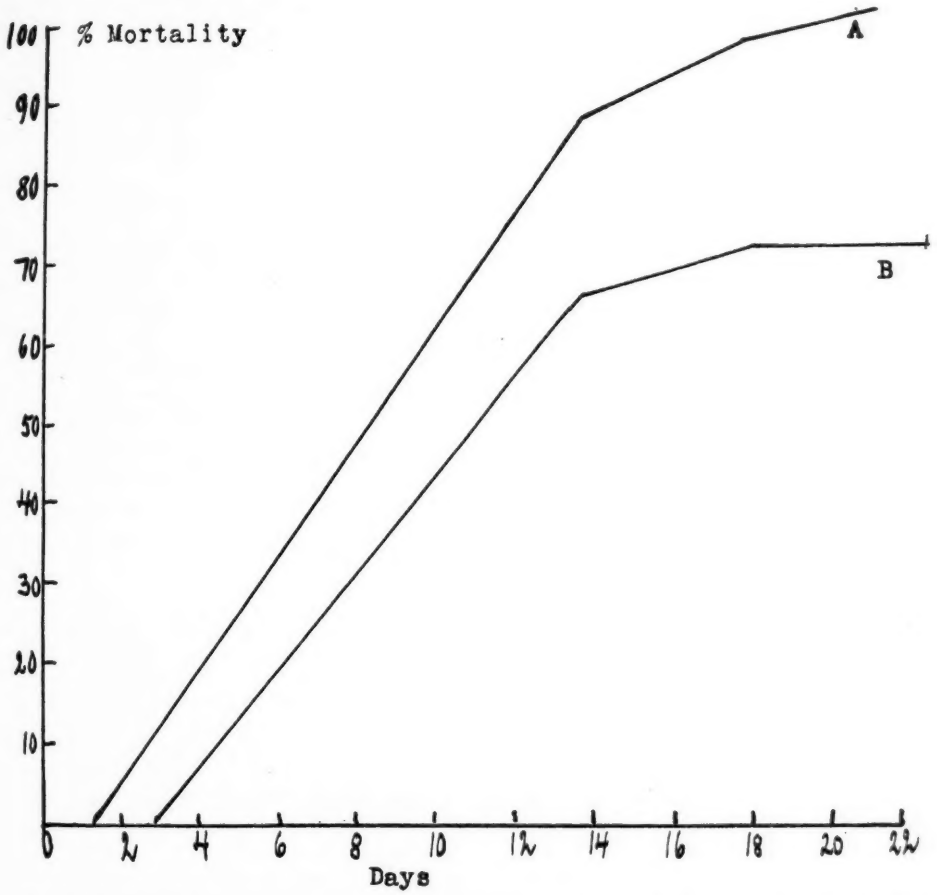


Fig. 13. Lethal effect in 10 cm. depth of the water phantom. Dose: 3,000 r measured in air. *A*, effect of x-rays: H.V.L. 1 mm. Cu, depth dose 34 per cent; *B*, effect of x-rays: H.V.L. 0.233 mm. Cu, depth dose 22 per cent.

Corresponding to ionization measurements this graph shows the greater lethal effect of the radiation *A* with the higher depth dose.

(*d*) It permits the simultaneous irradiation of large numbers of individuals.

(*e*) The average radiosensitivity of the goldfish is sufficiently constant the year around.

(*f*) The volume of the goldfish—within certain limits—does not influence the effect of radiation.

(3) While no attempt should be made

to replace ionization measurements by the use of biologic objects, the correlation of physical and biologic data, and the corroboration of physical data by corresponding changes in biologic objects seems to be of practical value from the clinical point of view.

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THE TWENTY-FOUR-HOUR GALL BLADDER[1,2]

By NATHAN B. NEWCOMER, M.D., *Denver, Colorado*

THE accurate interpretation of a gall-bladder examination by the cholecystographic method of Graham and Cole is not a simple matter. It is really a study to determine whether the gall bladder is functioning properly; and, if not, in what way it is at fault, to what extent its functions are abnormal, whether it is causing the symptoms of which the patient complains, if it is sufficiently damaged to require removal, whether it is causing disturbances of the adjacent organs, and if it is the only cause of the abdominal distress and symptoms. For such an accurate interpretation, we believe that a gastro-intestinal examination is an essential part of a gall-bladder examination.

Graham, Cole, Copher, and Moore (7), in their book state:

"The Cholecystographic Criteria of the Pathological Biliary Tract. These are, in the order of their importance, the following:
"Non-visualization of the gall bladder.
"Faint visualization of the gall bladder.
"Delayed appearance of the gall-bladder shadow.
"Deformity of the gall bladder.
"(1) Congenital.
"(2) Acquired.
"(*a*) Intrinsic.
"(*b*) Extrinsic, pericholecystitis.
"Cholelithiasis.
"Persistence of the gall-bladder shadow.
"Excessive size of the gall bladder."

We would add to the above criteria:

1. Routine twenty-four-hour gall bladder.
2. Mobility of the gall bladder.

The presence or absence of stones is important. Opaque stones can generally be shown without the dye. If sufficient dye enters the gall bladder, practically all non-opaque stones will be visualized. If the gall bladder is not visualized, particularly by the intravenous method, and all errors of technic can be eliminated, it is certain that the gall bladder is a non-functioning or surgical gall bladder. From 65 to 70 per cent of such gall bladders will carry non-opaque stones, and the remainder, with but few exceptions, will be markedly pathologic.

Faint visualization of the gall bladder, when the dye is given intravenously, indicates a definitely pathologic gall bladder. We believe this is subscribed to by all men using the intravenous method.

Scott and Moore (16), in 1938, stated: "We have no confidence in the radiological diagnosis of pathologic gall bladders because of faintness of shadow, when obtained by oral cholecystography." They conclude, "We feel that in intravenous cholecystography a faint gall-bladder shadow warrants a radiologic diagnosis of pathologic bladder."

In an article delivered by the writer and his co-workers, in December, 1927 (12), we reported 98 cases of light density gall bladders by the intravenous method. This group included the gall bladders which were markedly decreased in density at six hours, and faintly or not visualized at 24 hours, and were classified by us as chronic cholecystitis, unless stones were visualized. We have always believed a faint gall-bladder shadow indicates a markedly pathologic gall bladder when the dye is given by the intravenous method.

We would hesitate to advise operation upon finding a faint gall-bladder shadow by the oral method. If the oral method of administration is used and a faint gall-bladder shadow is obtained, we believe the gall bladder should be rechecked by the intravenous method. The faintly visualized gall bladder indicates either that the dye does not enter the gall bladder in sufficient quantity, or that the mucous

[1] Delivered before the Fifth Midsummer Radiological Conference, at Denver, Colo., July 29, 1939.

[2] Submitted for publication in February, 1940.

membrane is not able to concentrate the dye because it is diseased.

Excessively large gall bladders, while seen fairly often at operation, are seldom visualized by the dye method because they will not fill.

Deformity of the gall bladder, either congenital or acquired, is occasionally seen. The congenital types are prone to become pathologic, and the acquired types are probably pathologic even though they fill and concentrate the dye normally. The acquired types are generally caused by adhesions.

Delayed appearance of the gall-bladder shadow is seen only occasionally. Graham, Cole, Copher, and Moore (7) state:

"Late appearance of the image of the vesicle can be due to any parenchymatous condition of the liver which retards the excretion of the dye.

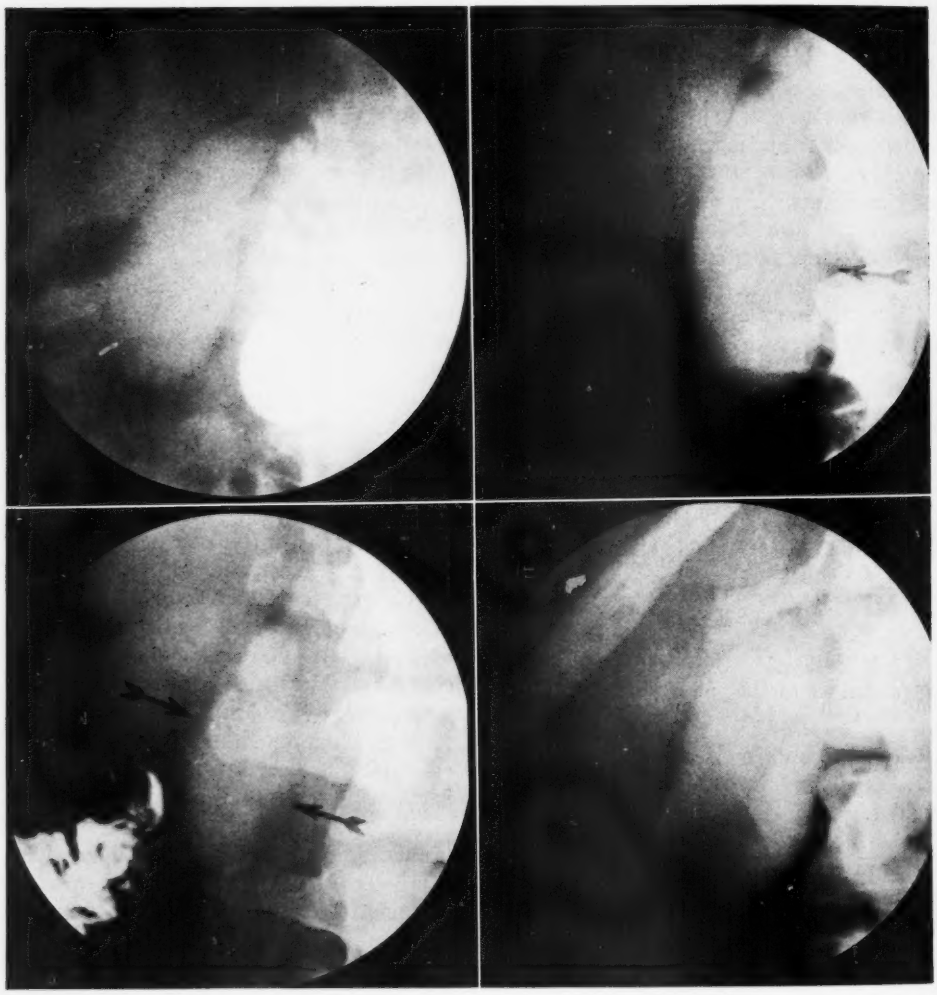

Fig. 1 (*upper left*). A visualized gall bladder at six hours.
Fig. 2 (*upper right*). The same case after a barium meal, showing a chronic duodenal ulcer. This illustrates the need for a gastro-intestinal examination in addition to the gall-bladder test.
Fig. 3 (*lower left*). The same case at 24 hours, showing a definite residue in the gall bladder.
Fig. 4 (*lower right*). Another case showing a definite residue at 24 hours. We believe the taking of a 24-hour negative will give additional information in regard to the condition of the gall bladder.

It is possible, but unlikely, that the intrahepatic-duct system might be so affected that in the absence of true obstructive phenomena, egress of the dye-filled bile might be slowed."

Occasionally, however, we have seen, after giving the gall-bladder dye test by the intravenous method, that a gall bladder will not fill at six hours, but after giving a normal solid meal, it will be seen to be normal in size, shape, and density, and will empty in 24 hours. We believe that this is due to a kinking of the cystic duct, preventing the filling of the gall bladder. After eating, if there are no adhesions present, the gall bladder moves upward and outward from one and one-half to two inches. This straightens the cystic duct and allows the bile to enter the gall

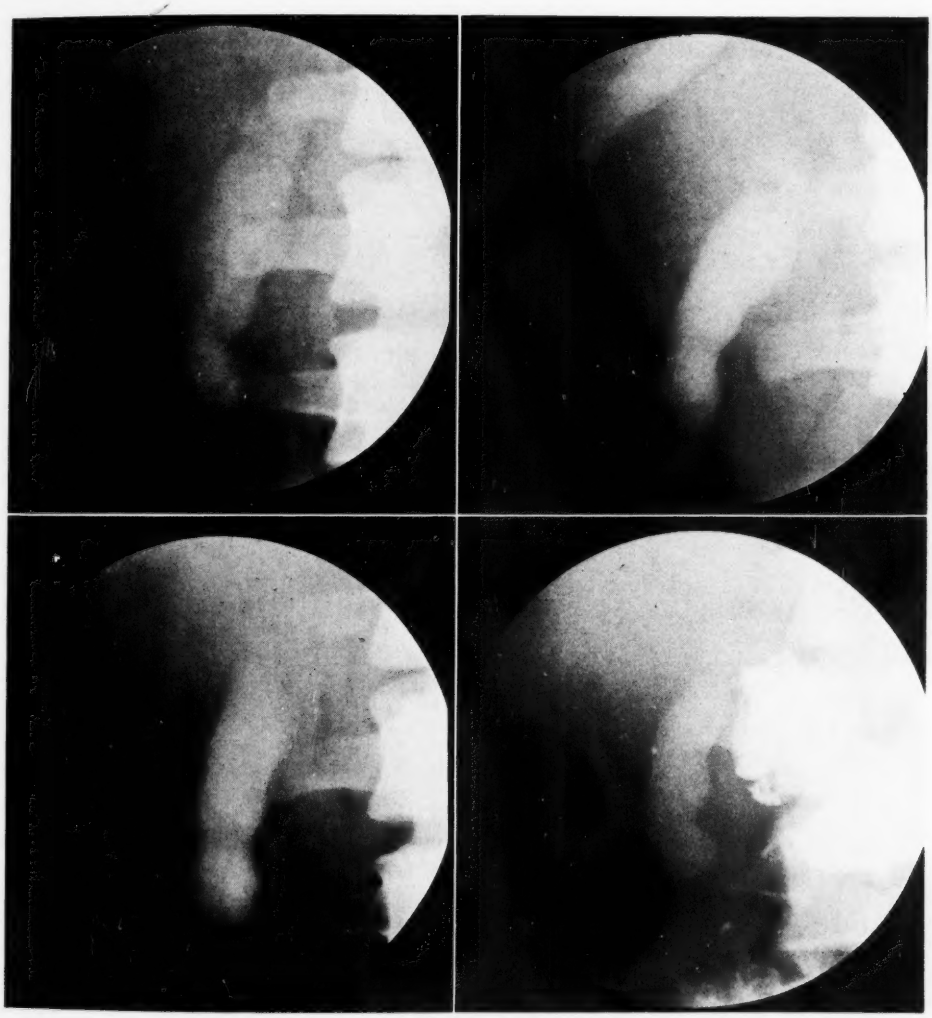

Fig. 5 (*upper left*). Intravenous method. Six-hour test, showing a long irregular gall bladder, normal in density.
Fig. 6 (*upper right*). The same gall bladder, after the patient had eaten a solid meal, shows limited mobility and is partially empty.
Fig. 7 (*lower left*). The same gall bladder at 24 hours, the same size as at six hours and increased in density.
Fig. 8 (*lower right*). The same gall bladder at 30 hours, after a barium meal, showing gastric retention. (Six-hour gastric retention.)

bladder. If it is not otherwise diseased or surrounded by adhesions, such a gall bladder will empty in 24 hours. This gall bladder should not be removed if it is not producing symptoms.

Graham, Cole, Copher, and Moore (7), in regard to the elimination of the dye, state:

"After the lapse of about twenty hours (depending on quality and frequency of food intake), the dye-containing bile begins to disappear and, in normal cases, at the end of 24 hours and on resumption of usual diet, the gall bladder can no longer be visualized. . . . By observation and experiment, we found that for the normal individual these periods of radiographic examination were at 4, 8, and 24 hours after the intravenous injection. If alimentary administration is resorted to, we follow approximately the usage of Menees and Robinson, Stewart and Ryan, and others, making the examination at 15, 19, and 23 hours following the ingestion of the dye.

"Therefore, if the image of the gall bladder is observed at examinations at later hours than it is seen in normal cases, an explanation aside from disease of the vesicle is to be sought. In such an event either the gall bladder does not evacuate its dense contents or they are replaced as rapidly as they leave the organ. Our observation leads us to believe that prolongation of the period of abstention from food most commonly produces this finding, particularly after the dye has been given by vein. . . . Undoubtedly in some instances there is reabsorption of the dye from the intestinal canal. If alimentary administration is resorted to, the larger amount of dye given could readily account for this occurrence. In either of the last two contingencies there is a continuous replacement of the dense bile as rapidly as it leaves the gall bladder. Whatever the cause of a persistent image of the organ may be, there is as yet no reason to consider this finding as evidence of cholecystitis."

In regard to the 24-hour retention, several questions arise.

Is it normal or abnormal for a gall bladder to be visualized at 24 hours? The consensus of opinion of most men who have written on the subject is that the shadow will disappear in that time in normal cases. In our own normal cases, the gall bladder is empty in 24 hours (after the second meal), by the intravenous method, or in 36 hours by the oral method.

We wish to quote the opinions of the following authors on retention of the dye:

Case (3) says:

"When the outline of the gall bladder is normal in size, shape, and position, and of normal density, but slow in disappearing, indicating that the evacuating power of the gall bladder is interfered with, we begin to enter a zone of interpretation where the report is less reliable. When the normal outline is faint in density, as well as slow in emptying, we feel that the significance is still greater. Under these circumstances, with slow emptying of the gall bladder with normal or increased density of the shadow, I believe we are justified in reporting chronic catarrhal cholecystitis. The operative indication in such a case will depend upon the history. If the history is at all suggestive of pathology, such findings would tend to strengthen the diagnosis; but on them alone, without symptoms or history to support them, I would never seriously consider surgery."

Menees and Robinson (10) state:

"On the morning films the gall bladder is at its largest and faintest. Following food, there is a decrease in size and an increase in density, in the normal gall bladder. The late afternoon films frequently show a further decrease in size. Normally, there is no dye left in the gall bladder on the second morning."

Stewart and Ryan (19) state:

"We had 16 cases which showed a persistent shadow up to and beyond 36 hours after the administration of the dye and only one of these was operated upon. The surgeon reported that at operation inspection of the gall bladder showed a bluish color, with no adhesions; it could be freely expressed and there was no evidence of stones. He considered this gall bladder normal and did not disturb it. It is a well known fact that cholecystitis of considerable degree can be present and not be discovered unless the gall bladder is removed or at least opened and the interior inspected. There is some doubt in the minds of the authors as to whether this case was a complete failure of diagnosis or not."

It is the custom among roentgenologists to give either a fat meal or an ordinary meal for the purpose of emptying the gall bladder after it is visualized. A fat meal is unnecessary (14). We have never used it, even at the beginning of our cholecystographic work, except for experimental pur-

poses. A normal gall bladder should empty with a normal solid meal.

Sherwood Moore (11) states:

"Another point on which we deviate from the methods employed, apparently with great advantage by other clinics and observers, is the omission of the fat meal. We have not considered that this is necessary for adequate performance of the test."

We believe if the gall bladder empties completely after the second meal, it is normal. Most roentgenologists report a gall bladder of normal density to be normal if it empties from one-half to two hours after a meal.

The problem before us then is, have we exhausted our diagnostic skill by reporting non-visualization, faint visualization, delayed appearance, deformity (congenital and due to adhesions), cholelithiasis, and

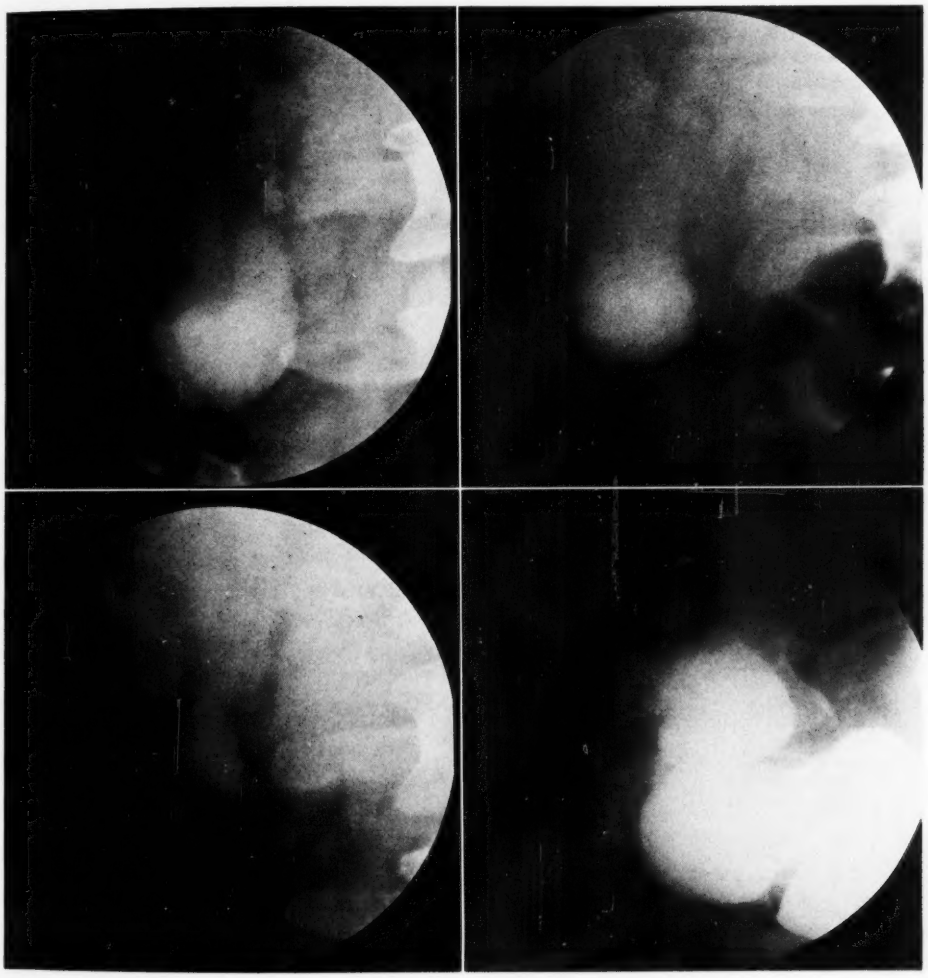

Fig. 9 (*upper left*). Intravenous method. Six-hour test, showing the gall bladder visualized, normal in density.

Fig. 10 (*upper right*). The same gall bladder, after the patient had eaten a solid meal, has emptied one-half.

Fig. 11 (*lower left*). The same gall bladder at 24 hours, showing a residue, normal in density.

Fig. 12 (*lower right*). The same case after a barium meal, showing the stomach in the mid-line, and the descending portion of the duodenum held markedly to the right.

(This series shows the advantage of taking a 24-hour negative, and correlating it with a gastro-intestinal series.)

excessive size of the gall bladder? Can a gall bladder be abnormal and not fall into the above classifications? If so, how can we discover such a gall bladder?

The normal gall bladder should fill with bile, concentrate it, and deliver it into the duodenum during the early part of digestion.

Can a gall bladder fill and concentrate the dye, yet not empty normally after a meal? Is it sufficiently pathologic to give symptoms if it does not empty itself? Should such a gall bladder be removed?

Kirklin, Caylor, and Bollman (9) give an excellent tabulation of 113 operative cases reporting the types of gall-bladder diseases found, the bilirubin content and density of cholecystographic shadow. We are reproducing in Table I that portion covering the chronic cases (101 cases). In 56 per cent, the shadow was absent; in 33 per cent, the shadow was faint, and in 12 per cent, the shadow was normal or increased. That is, in 27 per cent of the visualized pathologic gall bladders, the shadows were of normal or increased density.

Since the non-visualized and light density gall bladders are more apt to go to operation than the visualized normal density gall bladders, the percentage of pathologic normal density gall bladders in routine examination must be much greater than the figures given above.

Twenty-four-hour Gall Bladder.—From the beginning of our cholecystographic work, we have taken a 24-hour film in all cases in which the dye had been given. We felt that a normal gall bladder should empty completely after a meal; but, as we gave the dye intravenously at 9 A.M., took the first film at 3 P.M., and the second film at 5 P.M., after the patient had eaten a solid meal, we were not sure whether the gall bladder emptied completely since this would require taking films at night which was not convenient for either the patient or the technician. So we took the third film at 24 hours.

We did considerable experimental work on normal individuals before we concluded definitely that a gall bladder of normal density, visualized at 24 hours, indicated a pathologic gall bladder.

A review of the recent literature (four years) reveals little or no discussion on the twenty-four-hour retention. At a round-table discussion before this Conference

TABLE I.—TYPES OF CHOLECYSTIC DISEASE: COMPARISON OF VARYING DEGREES OF CONCENTRATION OF BILIRUBIN IN THE GALL BLADDER WITH ROENTGENOGRAPHIC SHADOWS OF VARYING DENSITIES[1]

Diagnosis	Bilirubin Content of Gall-bladder Bile, mg.				Density of Cholecystographic Shadow			
	Cases	High	Low	Average	Dense	Normal	Faint	Absent
Chronic								
1. Slight chronic cholecystitis	8	110	11	55.3		4	2	2
2. Chronic cholecystitis	12	66	3.9	30.4			5	5
3. Chronic cholecystitis with papilloma	9	60.5	22	39.6	2		4	5
4. Chronic cholecystitis with "strawberry" gall bladder	8	71.5	8.2	28.4		3	2	3
5. Chronic cholecystitis with "strawberry" gall bladder and papilloma	1	55		55			1	
6. Chronic cholecystitis with stones	46	110	0.0	26.8		2[2]	12	32
7. Chronic cholecystitis with stones and papilloma	6	55	4.2	28.1			2	4
8. Chronic cholecystitis with stones and "strawberry" gall bladder	10	55	3	20.6			5	5
9. Chronic cholecystitis with stones, "strawberry" gall bladder, and papilloma	1	16.5		16.5		1		

[1] Reprinted from a paper by KIRKLIN, CAYLOR, and BOLLMAN (9): The Concentration of Cholecystographic Mediums and Bilirubin by the Gall Bladder. RADIOLOGY, 9, 465, December, 1927.

[2] One in which stones did not show in cholecystogram.

three years ago, at which some forty roentgenologists were present, the question was asked, "What is the significance of the 24-hour gall bladder?" All except ourselves said they had had no experience with it.

In the earlier literature, an occasional reference is made to 24-hour retention.

Sherwood Moore (11) says:

"Our preference is always for the intravenous use of the dye, which is administered early in the morning, with radiographic examinations at 4, 8, and 24 hours."

Graham, Cole, Copher, and Moore (7) state:

"After the lapse of about 20 hours (depending on quality and frequency of food intake), the dye-containing bile begins to disappear and, in normal cases, at the end of 24 hours and on resumption of usual diet, can no longer be visualized; . . . Persistence of the gall-bladder image is indicative of lack of food intake or of intestinal re-absorption of the dye. We are not yet clear as to its significance."

While there are occasional references in the literature to retention of the gall-bladder shadow at 24 hours, there is practically no discussion as to its significance.

In an article by Newcomer, Newcomer, and Conyers (12), we reported on the 24-hour findings in a group of 360 cases, 285 of which were given dye by the intravenous method. We classified the intravenous cases into four groups:

"1. Those in which the gall bladder did not fill with the dye.

"2. Those in which there was decreased density of the gall-bladder shadow at six hours and faint or no visualization at all at 24 hours.

"3. Those in which the gall-bladder shadow was normal in density at six hours and plainly visualized at 24 hours.

"4. Those in which the gall bladder filled normally with the dye in six hours, was from one-half to two-thirds empty at eight hours (after the first meal), and empty at 24 hours (after the second meal)."

We made the following comments on Groups 3 and 4:

"Group 3 includes the gall bladders that filled normally at six hours; that is, were normal in size, shape, and density, and were plainly visualized at 24 hours. We classify these as cases of marked chronic cholecystitis.

"Thirteen were operated upon; 12 had chronic cholecystitis, one the surgeon said was normal. The one said to be normal had a markedly irregular cap after the barium meal and the gall-bladder shadow was still plainly visualized at 30 hours.[3] Of the 12 cases proven to have chronic cholecystitis, nine had been given barium meals and showed irregular caps.

"Thirty-seven were not operated upon. Twenty-five were given meals; 18 had irregular caps, and seven had normal caps.

"Group 3 included 50 cases diagnosed as chronic cholecystitis, of which 13 were operated upon and chronic cholecystitis found in 12; one the surgeon said was normal." (See Table II.)

"Group 4 includes all the cases we interpret as normal gall bladders; that is, they fill at six hours, are normal in size, shape, and density, are from one-half to two-thirds empty at 8 hours (after the first meal), and entirely empty at 24 hours (after the second meal).

"Forty-three were given meals; 14 had irregular caps, 10 of which were diagnosed as duodenal ulcers. In the remainder, the caps were normal. Nine were operated upon for ulcer or for appendicitis and the gall bladder was found to be normal in every case.

"Group 4 included 60 cases, of which 9 were operated upon for other conditions, and the

TABLE II.—GROUP 3. PATHOLOGIC NORMAL DENSITY GALL BLADDERS (50 CASES)[1]

Diagnosis		Operative Findings	Barium Meal Given	
Cholecystitis, 50	Operated on, 13	Cholecystitis, 12 Normal, 1	9	Deformed cap, 9
	Not operated on, 37		25	Deformed cap, 18 Normal cap, 7

[1] Fill normally in six hours but do not empty in 24 hours. There is no difficulty in filling but there is difficulty in emptying.

[3] This case was later re-operated upon.

TABLE III.—GROUP 4. GALL BLADDERS FILL AND EMPTY NORMALLY (60 CASES)

Diagnosis		Operative Findings	Barium Meal Given	
Normal gall bladder	Operated on for ulcer, etc., 9	Normal gall bladder, 9	43	Deformed cap, 14 Normal cap, 29

gall bladder found to be normal in each case." (See Table III.)

We also reported a small group which was given dye by the oral method.

"This method includes 75 cases, of which 13 were operated upon. These are divided into four classes, as follows:

"Group 1. Those in which the gall bladder did not fill. Non-functioning or surgical gall bladders.

"Group 2. Those in which the gall-bladder shadow was of decreased density at 16 hours, slightly or not visualized at 40 hours. These do not fill readily and are diagnosed as chronic cholecystitis, unless stones are visualized.

"Group 3. Those in which the gall bladder was plainly visualized at 16 and 40 hours. This group fills readily but does not empty readily; diagnosed as chronic cholecystitis.

"Group 4. Those in which the gall bladder was plainly visualized at 16 hours, and empty at 40 hours. These are normal cases.

"Group 3 includes 15 cases in which the gall bladders were plainly visualized at 16 and 40 hours, all diagnosed as chronic cholecystitis. They filled but did not empty readily.

"Four were operated upon, and chronic cholecystitis found in each case. Three had irregular caps; one, a normal cap.

"Of the 11 not operated upon, eight were given meals. Two had normal caps; six had irregular caps.

"Of the 15 cases in Group 3, four were operated upon and the diagnosis confirmed.

"Group 4 includes 16 cases in which the gall bladders filled at 16 hours, were from one-half to two-thirds empty at 20 hours (after first meal) and empty at 40 hours. These are normal gall bladders.

"Ten were given barium meals; three had irregular caps, of which two were duodenal ulcers; seven had normal caps.

"One was operated upon for appendicitis, and the gall bladder found to be normal."

In Table IV, we have assembled the data on 577 consecutive cases by the intravenous method, covering a more recent study not included in the preceding report. In this group of cases, 484 gall bladders were visualized.

Of these 577 cases, 230 were of normal density, and 254 were of light density. We consider all light density gall bladders

TABLE IV.—FINDINGS IN 577 CONSECUTIVE CASES WITH INTRAVENOUS ADMINISTRATION OF GALL-BLADDER DYE

	Cases	Stones—positive	Stones—questionable
Non-visualized	93	5	4
Visualized	484	10	8

	Normal Density			Light Density		
Visualized Gall Bladders (484)	Visualized at 6 hours	Empty at 24 hours	Visualized at 24 hours	Visualized at 6 hours	Empty at 24 hours	Visualized at 24 hours
Cases	230	96	134	254	81	173
Normal gall bladder visualized		77		We consider all light density gall bladders to be pathologic. The following other pathology was shown:		
Normal gall-bladder visualization, but the following other pathology was shown:		19				
Adhesions		10	46		17	30
Deformed cap		4	18		4	12
Abnormal shape of gall bladder		8	18		12	25
Abnormal size of gall bladder		3	5		7	6
Abnormal mobility of gall bladder		5	35		11	11
Abnormal position of gall bladder			17			8
Pressure on viscera		7	55		29	33
Long antrum of stomach			13			1
Food retention in stomach		2	8		4	8
Ulcer						
Duodenal		2	6		8	6
Peptic		1				
Gallstones						
Positive		1	1		4	4
Questionable		2	2		2	2

as pathologic, whether they are visualized at 24 hours or not. It is interesting, however, to note that there were 173 out of 254 light density gall bladders visualized at 24 hours.

Of the normal density gall bladders, 134 were visualized at 24 hours, and 96 were empty. In the empty 24-hour gall bladders, we found other evidence of pathology, such as adhesions, pressure, etc., in 19. Some of these had more than one type of pathology. It will be noted that many of the other types of pathology are seen in the light density gall bladders.

Of the gall bladders remaining filled at 24 hours, 83 were graded as III and IV. Fifty-one were graded as I and II, mostly II. We generally advise operation in Grades III and IV, and practically never receive a negative report from the surgeon. Grades I and II we consider borderline cases, and advise conservative treatment, but many of them go on to operation. The grading is based upon a correlation of the 24-hour retention, gastro-intestinal findings, history, and physical examination.

It should be understood that in all of the above cases there was either a presumptive history of gall-bladder disease, or else it was necessary to perform the dye test in order to clear up the diagnosis when the history and physical findings were obscure.

In office work it is difficult to check operative findings. Many of the heavy density 24-hour cases go several years before they consent to operation. Most of us know by experience, however, that we generally hear of the errors in diagnosis promptly.

Mobility of the Gall Bladder.—In previous articles (12, 13, 14, 15), we have shown that normally the antrum and cap are in intimate relation with the gall bladder; that, after eating, the antrum and cap are shifted to the right and upward from one and one-half to two inches, pressing the gall bladder against the liver; that disturbance of this normal relation always indicates a pathologic gall bladder, and that a lack of mobility of the stomach, antrum and cap, gall bladder, and liver interferes with the emptying of the gall bladder.

In taking gall-bladder films, we always focus on a point half way between the crest of the ilium and the last rib, and half way between the spinal column and the outer edge of the body. We have found that a normal gall bladder will move upward and outward about two inches after a solid meal. If it does not do so, it is almost certain not to empty in 24 hours. This lack of mobility is generally due to adhesions.

We have seen in the Kirklin, Caylor, and Bollman (9) table that 28 per cent of the visualized chronic pathologic gall bladders were of normal or high density. Inasmuch as the non-visualized and faint gall bladder cases are recognized as definitely pathologic, a larger percentage of them are operated upon. The probability is that a much greater percentage of normal or high density gall bladders than are seen in routine examinations are pathologic.

We believe that 24-hour retention of the dye is an indication of a definitely pathologic gall bladder, even though the visualization of the gall bladder at six hours and eight hours is normal. A barium meal should be given in these cases, and the history and physical findings should be correlated with the cholecystographic findings before grading them or making recommendations.

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A MILLION-VOLT X-RAY UNIT[1]

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THE type of exceedingly high voltage x-ray unit that we wish to describe in this paper is, in many respects, quite radically different from other designs (1, 2).

This new million-volt unit (Figs. 1 and 2) contains a low frequency resonance transformer with a coaxially mounted multisection x-ray tube within. The transformer and the tube are mounted in a grounded steel tank and compressed gas is used for insulation. The x-rays are produced from a tungsten target mounted in the end of an extension chamber projecting out from the bottom of the grounded tank. This new unit rated for operation at one million volts is very compact, simple to operate, reliable, entirely free from exposed high voltage and has a readily accessible x-ray target.

High Voltage Transformer.—The high voltage transformer (Fig. 3) consists of a low voltage coil of flat copper strip and a high voltage coil placed directly over it consisting of many thin flat sections spaced apart for ventilation.

Since this transformer operates at resonance frequency, no iron core is required. This permits the multisection x-ray tube to be placed within the coils. As a result, the tube has the benefit of electrostatic shielding provided by the transformer and its position insures simple and short electrical connections between the various tube electrodes and the intermediate voltage taps of the transformer.

The lower end of the high voltage coil is grounded to permit the x-ray target to be at ground potential. The upper end of the high voltage coil is shielded with a hemispherical radially slotted, brass spinning. The electrical circuit controlling the filament excitation of the x-ray tube cathode is enclosed within this shielded cap.

The total number of turns in the high voltage winding is so chosen that the natural period of oscillation is 180 cycles per second. This frequency is obtained from the 60-cycle three-phase power supply lines through the intermediary of a static frequency tripler unit.

The steel tank housing the transformer is lined with a magnetic shield, which provides a return path for the magnetic flux of the transformer. This cylindrical shield consists of narrow, overlapping strips of silicon steel electrically insulated from one another, and at the bottom of the tank there is placed a ring of similar strips.

The principal design features of this high voltage coil of many sections which generates the voltage are: (1) the potential is uniformly graded over the entire coil stack so as to prevent creepage over the solid dielectric between coils; (2) the x-ray tube placed in the interior of the coil structure is electrostatically shielded from the grounded tank, and (3) the coil stack mechanically supports the hemispherical shield at the high voltage terminal.

Multisection X-ray Tube Construction.—The multisection x-ray tube envelope (Fig. 4) consists of eleven sections of molded Pyrex glass tubing, each section being 3.5 in. in diameter and 4 in. in length. The glass tubing is sealed to Fernico rings which carry the intermediate accelerating electrodes of stainless steel.

The thermionic emitting cathode made with spiralled tungsten wire is mounted in an electrostatic focussing cup. The tube is supported by a metal flange bolted to

[1] Read at the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

For a more complete account of this work, see "A New Million-volt X-ray Unit." CHARLTON, WESTENDORP, DEMPSTER, and HOTALING. Jour. Applied Phys. **10,** June, 1939.

the grounded metal tank. This flange has been connected to the bottom glass section of the tube. An exhaust manifold for connections to the exhaust pump is bolted to the tube envelope with metal gaskets.

The exhaust system consists of an oil-diffusion pump backed up by a rotary oil pump. A charcoal trap placed directly over the diffusion pump keeps oil vapor from the tube. Ionization and Pirani-Hale gauges record the vacuum.

The metal tank housing the x-ray tube and transformer is made of sheet steel 3/8 in. thick, 48 in. in diameter, and 80 in. long. The joint between the two halves is made gas-tight by means of a rubber gasket bolted between heavy flanges.

X-ray protection is provided by a lead shield placed around the extension chamber, which has an equivalent wall thickness of five inches. A lead disk placed back of the cathode inside the hemispheri-

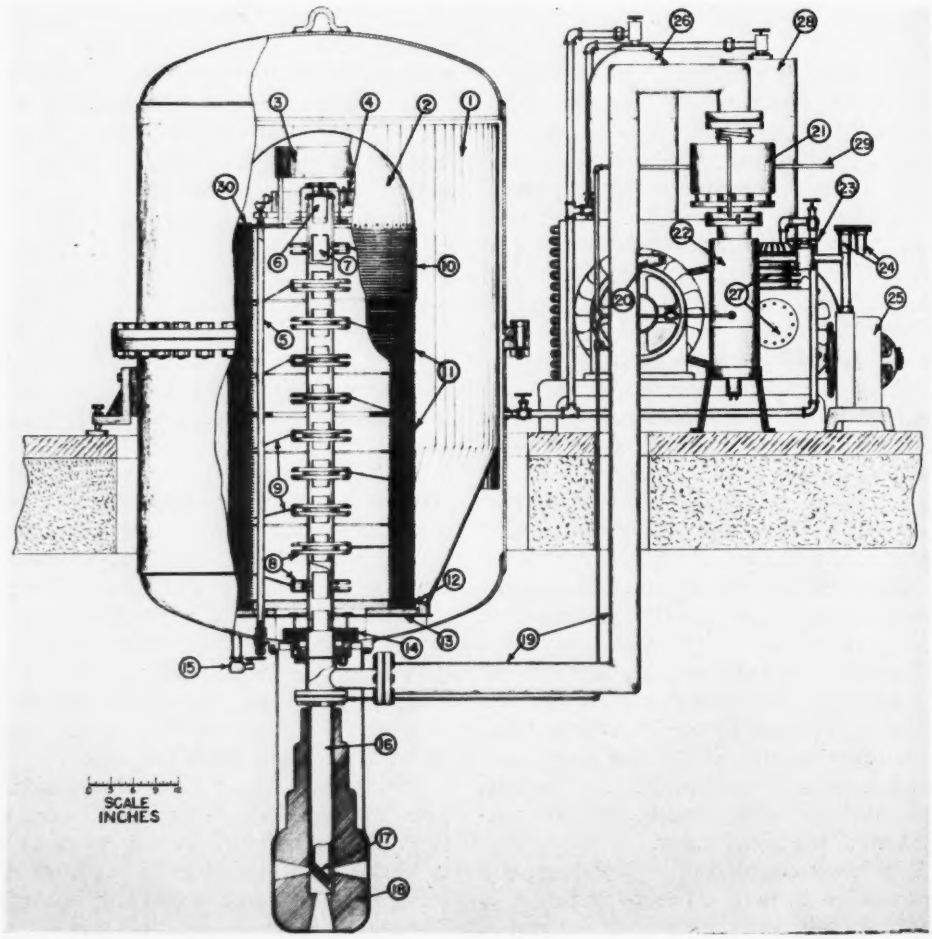

Fig. 1. Drawing of million-volt x-ray outfit: (1) Laminated steel shell; (2) slotted brass shield; (3) lead shield; (4) variable reactor; (5) insulating shaft; (6) cathode assembly; (7) first intermediate electrode; (8) shields around the seals; (9) tapleads; (10) secondary coils with copper tube shields; (11) secondary coils; (12) primary winding; (13) laminated bottom; (14) focussing coil; (15) filament control motor; (16) extension chamber with water jacket; (17) target; (18) lead shield; (19) vacuum line; (20) ionization gauge; (21) charcoal trap; (22) oil-diffusion pump; (23) vacuum shut-off valve; (24) Pirani-Hale gauge; (25) rough vacuum pumps; (26) Freon supply tank; (27) Freon compressor; (28) Freon storage tank; (29) cooling water inlet, drain omitted; (30) end-turn filament coil.

cal cap is used to absorb the x-ray beam which passes back through the axis of the tube. The quantity of lead required for primary protection is very materially reduced because of the small dimensions of the unit, approximately 1,000 pounds of cast lead being used. If lead shot is used for the same protection, because in certain cases of greater ease in handling, about 35 per cent increase in volume will be required.

The transformer is insulated from the tank with gas insulation at a suitable pressure. The gas used is dichlorodifluoro methane, "*F*-12." It is an odorless, non-toxic gas. If, however, it is mixed with oxygen in the presence of a gas flame, poisonous phosgene gas may be produced. The air is first exhausted from the transformer tank before the *F*-12 is introduced at a pressure of 40-pound gauge.

Electrical Power Supply.—Power is supplied to this million-volt unit from a 220-volt three-phase 60-cycle supply (Fig. 5). Current from this source passes into a static frequency tripler unit, which changes the power into a 230-volt single-phase 180-cycle current. The power generated at this frequency is fed into the primary of the x-ray transformer. The amount of power delivered is controlled by means of a saturable core reactor and an autotransformer.

End turns on the x-ray transformer supply current to the x-ray tube filament. An adjustable inductance placed in the filament circuit and located inside the hemispherical shield at the top of the transformer is controlled mechanically by a motor-driven connecting shaft, passing into the tank and up through the interior of the transformer coil.

The resonance transformer provides a simple method of obtaining a high voltage source for a self-rectified x-ray tube. When the unit is operating at 1,000 kv.p., the oscillating current in the secondary is of the order of 76 milliamperes. This large storage of energy permits the use of as much as 10 ma. of rectified current in the x-ray tube with practically no difference in the useful and inverse voltages. The wave form of the high voltage circuit is a smooth sine wave.

The replacement of the more usual iron core by the multisection x-ray tube in the axis of the transformer has simplified the insulation problem between the primary and secondary coils. The insulation space required has been very materially decreased and all electrical connections between the tube and the transformer are short and easily made inside the transformer and its hemispherical cap, thus providing adequate shielding from corona discharges.

Sliding discharges produced on the surface of the solid dielectrics employed in the construction of high voltage transformers are usually the limiting factor of a given

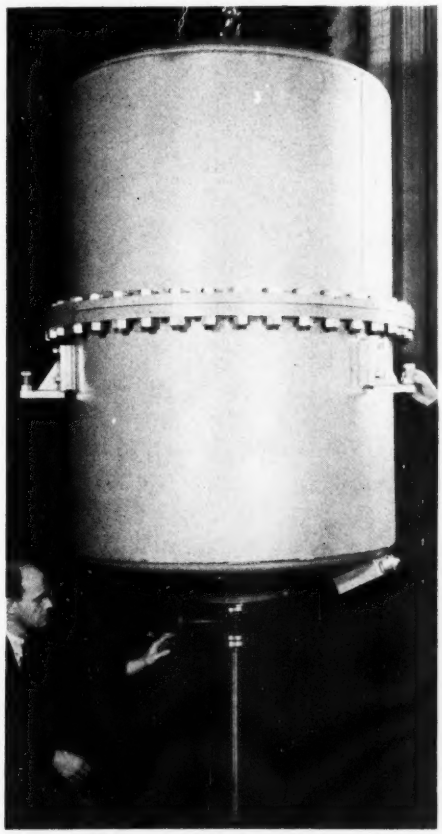

Fig. 2. Million-volt x-ray unit.

design in attaining very high voltages. Transformer designs which insure more uniform voltage gradients over the surface of the solid dielectric will markedly increase the maximum attainable voltage in a unit of a given size. The subdivisions of the secondary turns into so many thin coils provide a more effective distribution of generated voltage throughout the body of the solid dielectric and hence permit higher operating voltages. This multiplicity of secondary coils simplifies the placing of taps at equal voltage intervals for connection to the different intermediate electrodes. It permits random winding of the coils and it also permits the thin coils to be spaced apart sufficiently to permit better cooling through circulation of the gas.

The total height of the secondary is determined by the height of the x-ray tube. It is desirable to have the tube and the transformer the same length, not only for convenience in making electrical connections but also to keep the voltage levels of both tube and transformer more nearly equal throughout the column.

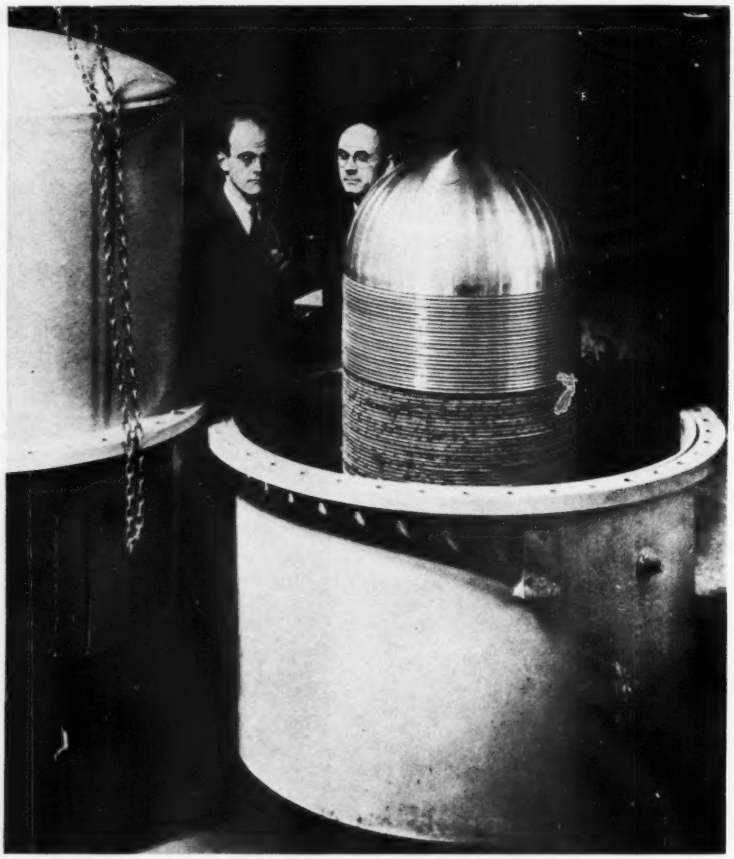

Fig. 3. Million-volt resonance transformer.

Split rings of copper tubing are placed around the upper sections of the secondary and connected to the outer turns of the sections. They serve as protection against possible arcovers to the tank wall which might possibly damage the insulation locally if such arcs occurred.

The Insulating Fluid.—Gas insulation (3) was chosen for this unit in place of oil because in very high voltage units of relatively low power it has distinct advantages. The data shown in Figure 6, obtained with a 60-cycle transformer, show the arcover voltages for three different insulating media as a function of pressure. The spacing between the high voltage terminal and the tank was about five inches and the curves are for *F*-12, 10-*C* transil oil and nitrogen. The data showing the breakdown strength of *F*-12 and of nitrogen in Figure 7 were obtained with the resonant transformer, which has a spacing of 10 inches between the high voltage terminal and the metal tank. The *F*-12 gives over 2.5 times the breakdown strength of nitrogen at the same pressure. For voltages of not more than 1,200 kv.p., *F*-12 at a gauge pressure of 40 pounds provides an ample factor of safety. A weight of *F*-12 of only 100 pounds in the tank will produce this pressure. If we were to use oil in this outfit, 12,000 pounds of it would be required to provide the same electrical protection and the tank would necessarily have to be larger. *F*-12 decomposes under the action of corona, producing free chlorine and fluorine which might attack the metals and insulating materials within the unit. Life tests to date indicate the absence of these effects. This is due largely to the fact that there is practically no corona in the unit operating at 1,000 kv.p.

X-ray Tube Operation.—Since the tube is placed in the axis of the transformer, the magnetic flux passing through it does not interfere with electron focussing. Toroidal shields, surrounding the tube and connected to the electrodes, electrostatically shield the electron beam. The size of the electron beam passing down the tube is determined largely by the cathode geometry and by the ratio of voltage used in the first section to that in the remaining ten sections. A magnetic focussing coil placed at the entrance to the extension chamber can change the diameter of the beam striking the tungsten target to any desired value. The cathode design is made to give an electron beam diameter of such a size that it will not strike any of the intermediate electrodes as it passes down the tube. This beam of the desired current density must be obtained with the hot tungsten filament operating at a temperature low enough to give a very long life. In this tube, a current of 3 ma. can be obtained with the filament operating at a temperature of 2,155° K. This operating temperature should insure quite a long life as far as filament evaporation is concerned. Positive ion bombardment resulting from operation of the tube under poor vacuum conditions is more apt to be the limiting factor determining filament

Fig. 4. The tube envelope for million-volt multisection x-ray tube.

life. This limitation can be removed, however, by automatic control preventing high voltage being impressed on the tube reversible motor activating the insulating shaft which controls the variable inductance in the filament circuit. If operation

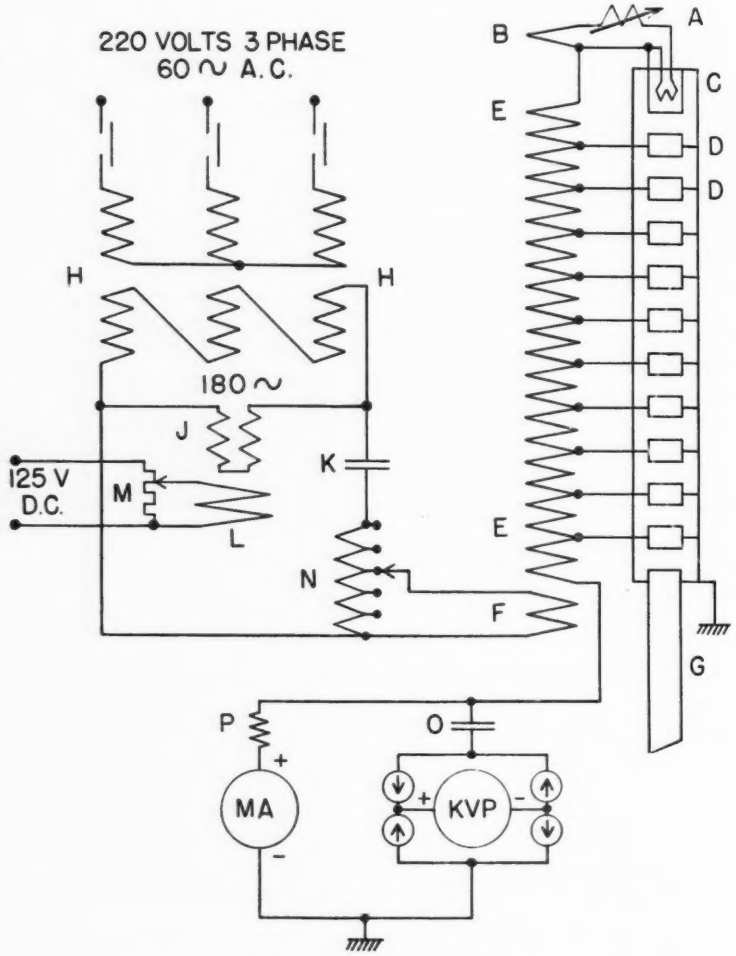

Fig. 5. The circuit diagram.

when the vacuum is too low for safety. The tube design permits the entire cathode assembly to be removed readily and replaced by a new one, when and if that becomes necessary, by a simple soldering operation. This essentially insures an extremely long tube life in this outfit.

Once the unit has been calibrated, its control operations are extremely simple. The current is adjusted by operating the is always at the same voltage and current, the impedance in the filament circuit will require practically no adjustment over long periods of time, and the autotransformer is permanently set to the desired voltage tap. The only control that then need be used for normal operation after the main switch is closed is the small and simple potentiometer controlling the direct current in the saturating winding of the

saturable reactor, which brings the x-ray tube quickly and smoothly from 300 kv.p. to 1,000 kv.p. and 3 ma.

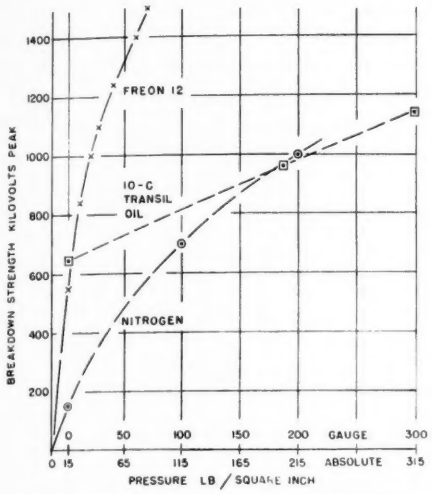

Fig. 6. Breakdown strength of different insulating media used to insulate an earlier 60-cycle transformer as a function of pressure.

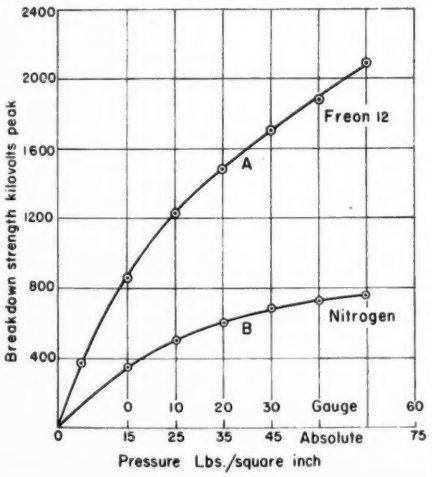

Fig. 7. Breakdown strength of nitrogen and Freon 12 when used as insulation for the resonance transformer as a function of pressure.

The voltage generated in the secondary coil is a linear function of the charging current required to charge the secondary to any given potential. As shown in Figure 5, the lower terminal of the secondary winding is connected to ground through a current and voltage measurement circuit. The reactor, P, allows the direct current

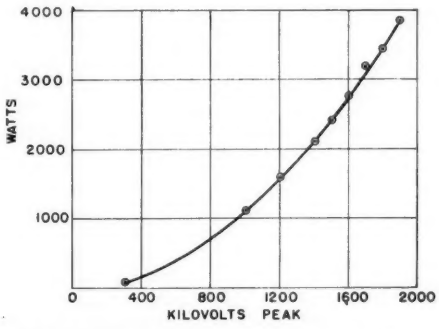

Fig. 8. Losses of transformer without tube as a function of kilovolts peak.

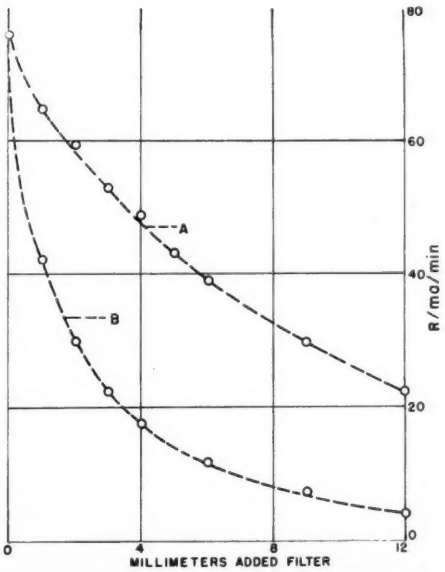

Fig. 9. X-ray measurements. Absorption curve for 1,000 kv.p. and 1 ma. 90 degrees to electron beam axis. Fifty cm. target–thimble distance. Inherent filtration 1.65 mm. of iron, 1 mm. of brass, 4 mm. of water. Curve A, added copper filter; Curve B, added lead filter.

component to pass through a milliammeter which registers the electron current flowing to the x-ray anode. The alternating charging current is blocked by the reactor, P, and passes through the capacitor, C, and a vacuum tube rectifier bridge. The rectified charging current passes through a

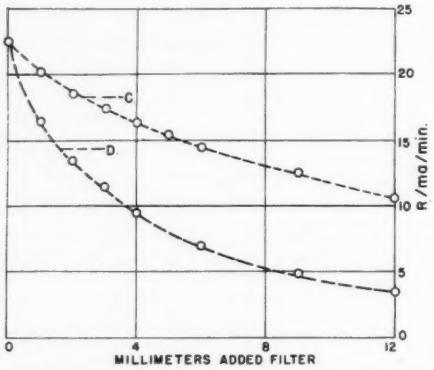

Fig. 10. X-ray measurements. Absorption curve for 1,000 kv.p. and 1 ma. Zero degree to electron beam axis transmitted x-ray beam. Fifty cm. target–thimble distance. Inherent filtration 1.5 mm. of tungsten, 4.75 mm. of nickel, 15.7 mm. of brass, and 4 mm. of water. Curve *C*, added copper filter; Curve *D*, added lead filter.

direct current milliammeter which is calibrated in terms of kilovolts peak. This calibration is carried out at low voltage by the use of irradiated sphere gaps. It is checked by the use of a cathode ray oscillograph connected to an insulated pick-up ring, in the top of the tank. It is also checked calorimetrically by a measurement of the heat generated in the anode from absorbed energy of the electron beam.

Operating Data.—The energy losses in this million-volt unit are relatively small. The principal losses in the x-ray transformer are due to heating of the secondary coils by the oscillating current and are proportional to the square of the voltage generated. There are small inherent losses in the frequency transformation in the static frequency tripler unit, and there are the unavoidable heat losses from the energy absorbed in the x-ray tube. Some operating data showing these losses are given in Table I.

If the transformer were to be operated at higher voltages, its inherent internal losses as a function of voltage would be as shown in Figure 8. The problem of dissipating the heat generated in the transformer must be carefully considered for any given continuous voltage rating.

The cooling of the transformer windings for operation at 1,000 kv.p. is accomplished by spacing the secondary coils 3/32 inch apart and permitting the gas to circulate through them by normal convection. At 1,000 kv.p. operation, the maximum temperature rise for continuous operation is 35° C. For continuous operation at voltages very much higher than 1,000 kv.p., a simple water-cooled heat exchanger with a blower to circulate the gas can be designed to keep the unit to any desired temperature.

X-ray Measurements.—A measurement of the intensity of the x-ray beam was made in two positions with reference to the tube axis: (*a*) 90° to the main tube axis and (*b*) 0° to the main tube axis parallel with the electron beam. As has been shown by others (4), the x-ray intensity and also the x-ray quality per milliampere of electron current is dependent on the angle with reference to the tube axis at which the measurement is made, because of the forward x-ray scattering factors that become accentuated as higher voltage x-rays are generated. Figure 9 shows the x-ray absorption curves with (*A*) copper and (*B*) lead for the 90-degree beam, and Figure 10 shows the x-ray ab-

TABLE I.—INPUT POWER DATA AS A FUNCTION OF OUTPUT POWER FOR HIGH VOLTAGE UNIT

3-phase 60-cycle Line				180-cycle Power from Tripler					Charging Current	Tube Voltage	Tube Current
Volts	Amp.	Kv.a.	Watts	Volts	Amp.	Kv.a.	Watts	PF%	Ma. Avg.	Kv.p.	Ma.
218	40	15.0	2,300	143	8.8	1.25	1,200	96	76.0	1,000	0
217	45	17.0	4,900	190	19.8	3.75	3,600	96	81.2	1,000	3
216	51	19.2	6,700	220	27.2	6.00	5,200	87	84.5	1,000	5
213	80	29.5	12,300	330	43	14.2	9,800	69	86.6	1,000	10
218	41	15.5	2,880	172	10.5	18.0	1,730	96	91.2	1,200	0
216	49	18.2	6,040	224	21.5	4.81	4,620	96	96.2	1,200	3
215	60	22.5	8,380	245	30.0	7.35	6,530	89	99.5	1,200	5

sorption curves with (*C*) copper and (*D*) lead for the zero-degree beam. These curves clearly show the change in quality with the beam angle. Table II shows the change in x-ray intensity per milliampere of current with the x-ray beam passing through the same amount of inherent filtration at zero degree and at 90 degrees to the tube axis and for different voltages. The intensity of the beam in the forward

TABLE II.—CHANGE IN INTENSITY OF THE X-RAY BEAM PER MILLIAMPERE WITH KILOVOLTAGE, AS MEASURED ALONG THE AXIS PARALLEL WITH THE ELECTRON BEAM AND AT 90 DEGREES TO IT

(50 cm. Target–thimble Distance)

		90° Beam		
Kv.p.	0-degree Beam Inherent Filtration* r/ma./min.	Inherent Filtration† r/ma./min.	Equivalent Filtration‡ to 0-degree Beam r/ma./min.	X-ray Beam Ratio 0°/90° through Equivalent Filtration
800	10.0	44.0	3.8	2.6
900	15.6	58.5	5.7	2.7
1000	22.5	76.0	8.0	2.8
1100	32.0	92.0	11.0	2.9
1200	43.5	108.0	14.5	3.0

* Inherent filter 0-degree beam = 1.5 mm. tungsten + 4.75 mm. nickel + 15.7 mm. brass + 4 mm. water.

† Inherent filter 90-degree beam = 1.65 mm. iron + 1 mm. brass + 4 mm. water.

‡ Equivalent filter 90-degree beam = inherent filter + 1.5 mm. tungsten + 4.75 mm. nickel + 12.7 mm. copper.

TABLE III.—CHANGE IN INTENSITY OF THE X-RAY BEAM WITH MILLIAMPERAGE AT CONSTANT VOLTAGE AS MEASURED ALONG THE AXIS PARALLEL WITH THE ELECTRON BEAM AND AT 90 DEGREES TO IT

(50 cm. Target–chamber Distance)

Kv.p.	Ma.	0-degree Beam Inherent Filtration* Total r per Min.	90-degree Beam Equivalent Filtration† to 0-degree Beam Total r per Min.
1000	1.0	22.5	8.0
1000	3.0	62.4	21.6
1000	9.0	196.7	68.8

* Inherent filtration 0-degree beam = 1.5 mm. tungsten + 4.75 mm. nickel + 15.7 mm. brass + 4 mm. water.

† Equivalent filtration to 0-degree beam = 1.65 mm. iron + 1 mm. brass + 4 mm. water + 1.5 mm. tungsten + 4.75 mm. nickel + 12.7 mm. copper.

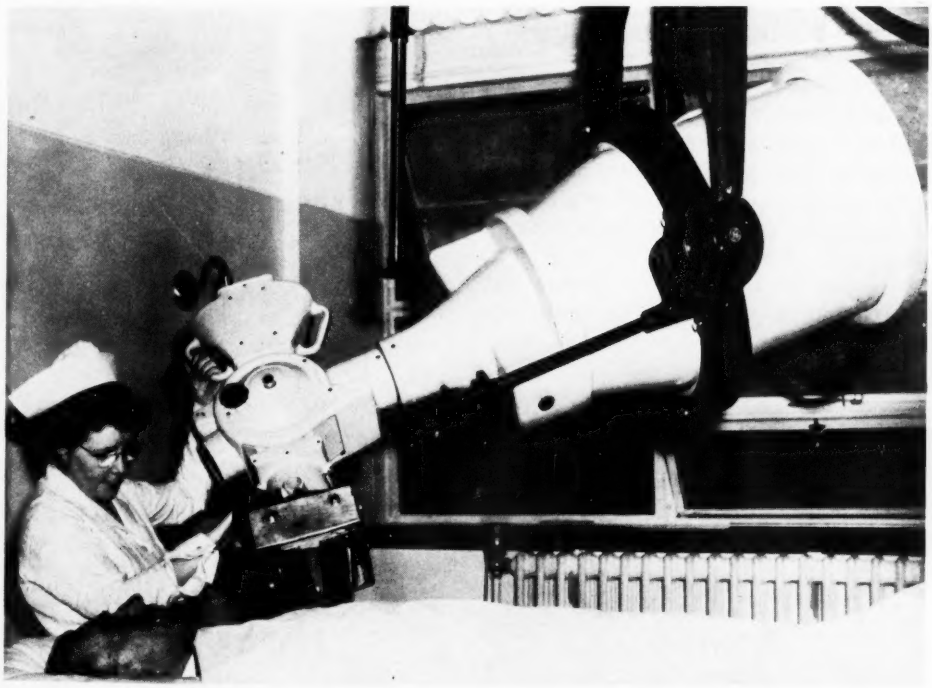

Fig. 11. Two hundred and fifty kv.p. resonance transformer x-ray unit.

direction parallel with the tube axis is practically three times the value of the 90-degree beam for the same equivalent filtration. At a constant voltage the x-ray output increases linearly with x-ray tube current (Table III), as is to be expected.

X-ray units of this basic design can be built for a wide range of voltages. In units for operation at lower voltages, it may be desirable in some instances to use oil insulation in place of gas, to facilitate cooling. In one x-ray unit of this basic design built for continuous operation at 250 kv.p. and 30 ma., 10-*C* transil oil is used to meet the necessary insulating and cooling requirements. This unit (Fig. 11) is housed in a tank 21 in. in diameter and 32 in. high. The multisection x-ray tube in this case is sealed off the pump, which increases the mechanical flexibility of the x-ray unit.

High voltage transformers can be built for the x-ray art designed to resonate over a wide range of frequencies. Units for voltages beyond one million volts can be designed to operate at a wider choice of resonant frequencies. This permits such units to be built to resonate at standard frequencies, such as 60 cycles, if desired, and thus further simplify the electrical equipment necessary for the production of very high voltage x-rays, by the elimination of frequency changing equipment. The development of such x-ray equipment for still higher voltages perhaps depends largely upon the demand for ranges of still shorter x-ray wave lengths for useful applications.

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DISCUSSION

LEONIDAS MARINELLI, M.A. (New York City): I think it might be of interest to this audience if I were to present briefly some features of the actual installation of this remarkable x-ray unit which represents such a definite advancement in the design of supervoltage equipment.

Following Dr. Charlton's presentation of the construction of the machine, the main problem to be considered is the protection to the operating personnel and the setting up of the patient in the most comfortable way for treatment.

The general layout of the unit as installed at Memorial Hospital is shown in Figures 1 and 2.

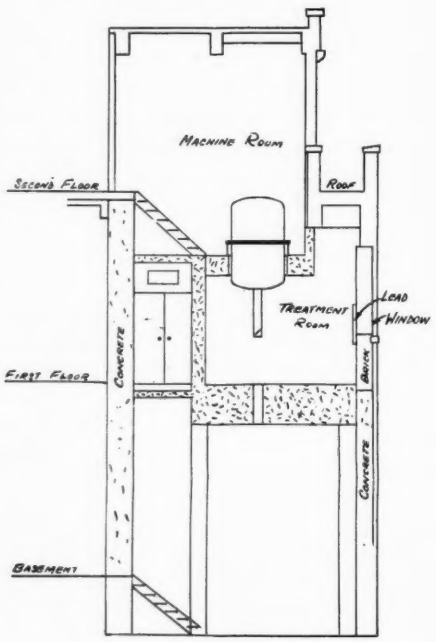

Fig. 1.

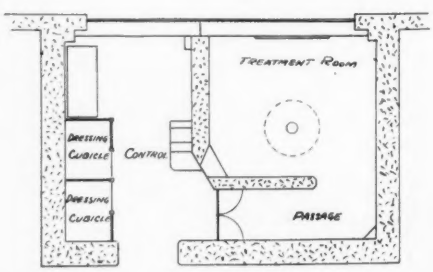

Fig. 2.

Figure 1 shows the vertical cross-section. The upper room houses the pumps, the tripler, and the upper part of the tank. when the wooden door is open and less than one-fiftieth of a tolerance dose when the door is closed.

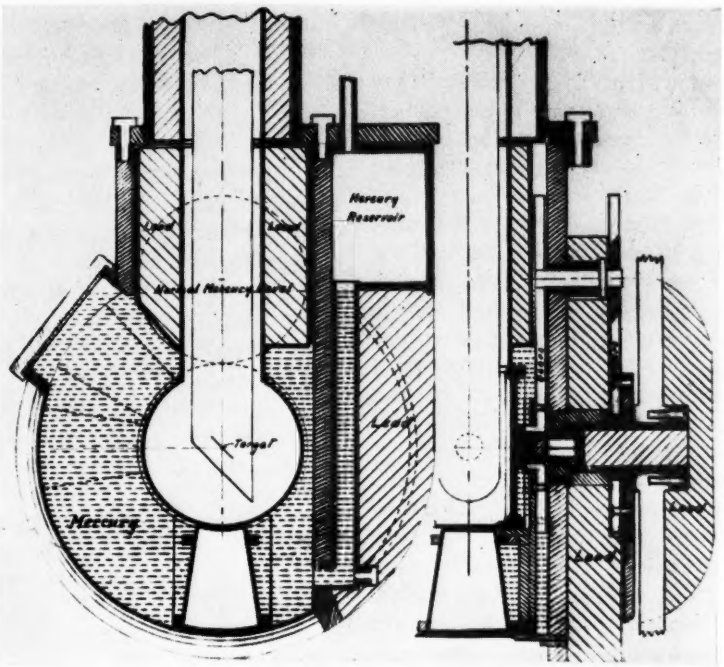

Fig. 3

The tank rests on a concrete floor 1 1/2 ft. thick and it is so placed that the anode of the tube projects to a height of 57 in. from the floor of the treatment room which, as you see, is situated immediately below.

The floor of the treatment room is 36 in. thick. Two walls are 24 in. thick, one 18 in. thick, and one 15 in. thick. This acts as a baffle, absorbing scattered radiation which would otherwise fall on the lead door leading to the treatment room.

Before going on to Figure 2, I may mention that the x-ray intensity at the top and sides of the tank varies from three to nine times 10^{-5} r per second. Since there is no reason, however, for anybody staying in this room during treatment, this intensity presents no hazard. In fact, at the corridor on the second floor, our measurements show one-tenth of a tolerance dose

The floor plan of the treatment room is shown in Figure 2. The purpose of the concrete baffle is here apparent, inasmuch as it shields the door and permits the use of only one-half inch of lead at the door. No radiation is detectable anywhere in the outside corridor or in the adjacent rooms.

The observation window consists of a good-sized tank of water 10 in. thick backed by 5.35 mm. of lead glass. It is overlapped by a plate of lead one inch thick. The visibility is excellent and at the window itself the observable radiation is of the order of one-twenty-fifth of a tolerance dose.

In general, it may be stated that the protection is more than ample. This has been done in view of an eventual increase in the operating voltage of the x-ray machine.

At the window, for instance, Dr. Failla had an intention of having, instead of water, a saturated solution of lead nitrate and lead acetate. This scheme would have provided an additional protection of about one-half inch of lead, which is not required at the present time.

The extension chamber of the x-ray tube (Fig. 3) is surrounded at its upper portion by lead and by mercury and lead at its lower portion. The useful beam is selected through an empty truncated cone made of iron which is immersed in the mercury. The spacings between this cone and the walls of the container are 1 mm. at each end, thus allowing an effective filtration of 2 mm. of mercury. The truncated cone may be rotated in the vertical plane about the center of the target as an axis. In this fashion it is possible to select a beam inclined from 0° to 90° of the vertical.

The dimensions of the port can be easily changed by changing the truncated cone in the following way: First, sufficient mercury is transferred to a suitable reservoir by suction; the cone is then rotated to the left, removed, and substituted for by the proper one.

One has thus the advantage of dealing with small weights when changing the size and shape of the port, and the advantage also of inclining the beam without unusual effort. The variation in the direction of the beam permits the administration of supervoltage x-ray without discomfort to the patient. The unavoidable inconvenience presented by the variation of intensity with angle is not very serious because only 45° are necessary for most treatments. Within this limit the variation in intensity is not excessive. It can be, in any case, corrected by suitable filters placed permanently on the outside wall of the mercury container.

R. R. NEWELL, M.D. (San Francisco): Could I ask Dr. Dempster a question? You have now a multisection tube which operates so nicely, and you have designed this most ingenious transformer to run it, but, of course, we have to look at two other possible power plants. One would be a perfectly standard transformer in chain connection such as you have provided for testing sets in various places; and the other possibility would be a Vandegraff electrostatic generator to operate the same tube.

Would either of those be applicable, and what would be the economics of the situation?

E. E. CHARLTON (Schenectady, N. Y.): I wish to thank Dr. Marinelli for his discussion of our paper, giving more details concerning an installation of one of these units at the Memorial Hospital in New York City.

Dr. Newell's request for an economic comparison of this type of supervoltage x-ray unit with cascade transformer systems and electrostatic generator units is not an easy one to meet. I would prefer that my own discussion at the moment be primarily concerned with the research aspects, because the general economics of the supervoltage problem involves, of course, many factors. In such comparisons, one must also be mindful of the safety factor used in the operating voltage rating that is given any unit.

No cascade transformer x-ray units, all enclosed in one grounded metal container, of comparable size for this rated voltage, have been built. In general, one should expect a gain in the over-all economy of operation as the volume and weight are reduced for a given voltage rating. There are very limited life test data available at present of electrostatic generators of comparable size operating at this voltage.

It is only after units of the different types have been in continuous service for a long period of time that one can give a sound discussion of the economic factors which Dr. Newell has requested.

The absence of moving parts in the resonance transformer unit is an inherent advantage in offering greater possibilities of freedom from troubles when the outfit is in continuous operation for many thousands of hours.

Design features which concern the potential distribution along the surface of the solid dielectric are of the greatest importance in determining the rated voltage and the safety factor built into a unit of a given size.

The resonance transformer x-ray unit does seem to combine these considerations with a simplicity of construction, assembly, and operation that offers great possibilities of over-all economy when in continuous service over long periods of time.

TREATMENT OF CANCER OF THE LIP AND MOUTH[1]

By GEORGE E. PFAHLER, M.D., Sc.D., Professor of Radiology, Graduate School of Medicine, University of Pennsylvania, *Philadelphia*

MUCH progress has been made throughout the world in the treatment of cancer of the mouth. More patients have been cured within the last few years than during any previous period. More physicians have become interested in the disease, developing a broader knowledge concerning its nature and the manner of the spread of cancer in general than at any time before. Even with all this improvement, however, and with the satisfaction that comes to the radiologist from success in the treatment of a few advanced cases, our greatest opportunity and hope lie in the prevention of cancer of the mouth by treating skillfully and thoroughly the lesions which precede cancer.

Prophylaxis.—It is fortunate that any lesion occurring in the mouth usually gives early symptoms and can be recognized by the patient and by the physician, if consulted, almost at the very beginning. Any erosion, fissure, papilloma, leukoplakia, swelling or induration, ulceration, or lump can be recognized by the patient and can be examined and diagnosed by the attending physician almost from the day of onset. Any abnormal dryness, scaling, erosion, fissure, induration, ulceration, or swelling of the lip can be seen and felt and diagnosed at once. Therefore, the development of cancer and the failures in the treatment of cancer of the mouth are due almost entirely to ignorance, neglect, or, at least, lack of alertness at the beginning. The first physician consulted has the best opportunity for cure, and delay or faulty treatment may lead to loss of life. It is evident, therefore, that our greatest opportunity for control of cancer of the mouth lies in the education of the general public and in an increase in alertness, knowledge, skill, and sense of responsibility of the physician first coming in contact with the patient who has some kind of lesion on the lips or within the mouth. More progress can be made by efforts in this direction than by searching for some kind of remote specific cure or by increasing our technical equipment or even by any special technic which any one of us may have developed for the treatment of an advanced case. "Keep the mucous membrane of the lip and mouth healthy" must be our motto.

I have seen few, if any, cases of cancer of the lip or mouth which, in my opinion, began as cancer. I have had a few cases of cancer of the lip which, according to the history, began suddenly as herpes simplex (or fever blister). This condition may possibly have been cancer at the beginning. The fact that cancer can begin like a fever blister indicates that we must be on guard so that if a fever blister does not show signs of healing in two weeks, it should be examined by a physician experienced in treatment of cancer. Everyone will admit that these early non-cancerous lesions which, at times, lead to the development of cancer can all be cured or healed successfully if treated thoroughly and skillfully at the beginning. Therefore, insofar as these lesions are brought to the trained physician before they become cancerous, and are treated skillfully and thoroughly, cancer of the lip and mouth can be prevented. In my opinion, the majority of cancers of the lip and mouth should be prevented in the future.

Treatment of Precancerous Lesions.—Precancerous lesions are those which sometimes develop into cancer. We often obtain a history from the patient or the family physician of such lesions having preceded the cancer. At times such lesions appear, heal, and recur, finally becoming evident as cancer. Such experience may lead the

[1] Presented before the Third International Cancer Congress, under the auspices of the International Union Against Cancer, Atlantic City, N. J., Sept. 11–16, 1939.

patient and oftentimes the family physician to hope for cure by simple means, thereby causing delay which may result in advanced disease. We also can recognize these as precancerous lesions because we may find a small area cancerous and the remainder of the same lesion benign. It is generally advisable, therefore, to consider the possibility of cancer when a lesion does not show a tendency to heal within two weeks. Shortly thereafter, if in doubt, it would seem wise to consult an experienced physician, with the object of restoring the mucous membrane to health.

In general, every physician should examine the mouth of every patient carefully every time he sees the patient. The patient should know the ordinary rules for oral hygiene, and these should be emphasized by the physician. If any unhealthy condition of the mucous membrane is found, or any roughness of the edges of the teeth or artificial denture is causing irritation, steps should be taken immediately to correct them. An *erosion* will likely disappear after removal of its cause, or after the application of nitrate of silver. I believe, however, that I have seen cancer caused by long continued applications of nitrate of silver. Therefore, I believe such applications should not be continued longer than two weeks without improvement.

Fissures may also heal after one or two applications of nitrate of silver, but I have had best results following local destruction by electro-desiccation.

Papilloma is, I believe, best removed by electro-desiccation at once, under local anesthesia.

Leukoplakia demands the cessation of the use of all forms of tobacco, the removal of any irritation from the teeth, and the treatment of syphilis if present. In the early stage, a simple alkaline mouth wash may be successful. When keratinization has definitely taken place, the tissue should be destroyed by electro-desiccation followed by local application of radium plaques sufficient for an erythema dose, given preferably at once, little, if any, filtration being necessary.

Swelling, induration, or ulceration demands the removal of the cause and treatment accordingly. When first seen by the physician in a case of leukoplakia, these three conditions can easily be due to cancer. When in doubt, a biopsy should be taken after preliminary irradiation with from 1,200 to 1,800 r. Even a dose of 600 r has, I believe, some prophylactic value against the spread of cancer.

Early Cancer of the Lip.—The more we write and talk about the early signs, symptoms, and successful treatment of cancer by inoffensive means, the less late cancer we will have to treat and the lower will be the morbidity and mortality rates. The precancerous lesions of the lip are dryness, scales or crusts, fissures, leukoplakia, papilloma, erosions, ulcers, and "fever blisters." These usually exist for considerable time, but pass almost imperceptibly into cancer. When I doubt that the lesion is benign, I remove a specimen for microscopic examination and immediately destroy the remainder by electro-desiccation. This is a simple procedure and gives a most satisfactory result. When dealing with cancer which can be recognized clinically and before it has grown larger than 0.5 cm. in diameter, I surround the lesion by electro-desiccation and then remove it with curved scissors, or, if it is larger, so that the specimen will not be destroyed by the operation, I remove the entire lesion by electro-surgical dissection. Christie and his associates and C. L. Martin destroy these lesions locally with x-rays. I have used local irradiation but the method which I describe permits a biopsy, is certain, and, though it leaves a scar, I have gotten the impression that the tissues of the lip have more vitality after the above treatment than when destroyed by irradiation, and I have never had a local recurrence. It leaves a good functioning lip.

The larger and more advanced cancers of the lip can also be removed by electro-surgery, and, if necessary, the defect can be closed by plastic surgery when the cancer is cured. However, a better cosmetic result can be obtained from treatment by

irradiation which can be accomplished by surface applications of radium embedded in molds made of dental compound, or, better, by embedding small quantity radium needles, as described and recommended by C. L. Martin. The prophylactic and active treatment of the neighboring lymphatics will be considered after the discussion of cancer in the mouth.

By means of the above procedures in the treatment of cancer of the lip, I have obtained 98 per cent five-year cures in those lesions up to 1.5 cm. in diameter; 68 per cent in the larger ones, and 48 per cent of those with palpable lymph nodes.

A statistical study (Table I) of all my private cases of cancer of the lip has been prepared by my associate, D. A. Sampson, M.D.

TABLE I.—CANCER OF THE LIP

(Statistical Study by D. A. Sampson, M.D.)

	Five-year Results: Cases seen up to July 1, 1934						Three-year Results: Cases treated up to July 1, 1936						Cases first treated since July 1, 1936			Total Cases
	Alive	Dead due to cancer	Percentage of survivals	Died of intercurrent dis.	Not traced	Total	Alive	Dead due to cancer	Percentage of survivals	Died of intercurrent dis.	Not traced	Total	Alive	Dead of cancer	Total	Total, all cases
(*A*) Primary																
(*a*) Localized (less than 1.5 cm. diam.)	92	3	97%	20	9	124										
(*b*) Extensive (more than 1.5 cm. diam.)	19	8	70%	8	1	36										
(*c*) Cases with palpable lymph nodes	14	7	67%	3	6	30										
Total of primary cases	125	18	87%	31	16	190										
(*B*) Recurrent after treatment elsewhere																
(*a*) Localized	32	0	100%	2	4	38										
(*b*) Extensive without palpable nodes	8	5	62%	1	5	19										
(*c*) Cases with palpable nodes	5	14	38%	3	1	23										
Total of recurrent cases	45	19	70%	6	10	80										
(*C*) Total of primary and recurrent cases																
(*a*) Localized	124	3	98%	22	13	162	145	1	99%	17	9	172				
(*b*) Extensive without nodes	27	13	68%	9	6	55	34	12	74%	7	3	56				
(*c*) Cases with nodes	19	21	48%	6	7	53	30	21	59%	4	9	64				
Total	170	37	82%	37	26	270	209	34	86%	28	21	292	17	0	17	309
(*D*) Cases with palpable nodes treated by insertion of radium needles*	3	8	27%	0	0	11	4	9	31%	0	0	13				

* Duration of life after needling lymph nodes up to 1 year, 6 cases; 1 to 2 years, 2 cases; 2 to 3 years, 1 case; 3 to 4 years, 1 case; 5 to 6 years, 1 case, and 11 to 12 years, 2 cases.

Cancer of the mouth is always a serious problem, because metastasis is likely to occur early and it may be extensive. Therefore, skillful management of the patient and the lesion at the first visit to the physician will give best chance for cure. The cure depends then upon the promptness with which the patient first consults his physician. The form of treatment of cancer of the mouth will depend upon the size of the lesion, duration, location, extent, and grade of malignancy. Careful examination and accurate diagnosis is, therefore, the first step. I believe that the best treatment of cancer in the mouth is by irradiation but the technic for applying the irradiation will vary with the above factors. No rule can be laid down for the treatment of cancer until cancer can be made to grow according to rule. The actual presence of cancer can usually be determined clinically by an experienced physician, but the grade of malignancy or the degree of cellular differentiation can be determined only microscopically. Therefore, a biopsy is necessary. A biopsy is often required also for differentiation from other lesions which simulate cancer. There is some risk in taking a specimen, especially when there is any delay in obtaining the report. For that reason, for many years I have been giving preliminary irradiation of from 1,200 to 1,800 r in all cases before the biopsy. Even then I ask for a report within 24 hours. The technic must not only be adapted to the individual case, but must be changed during the treatment according to the conditions which develop. For example, an early cancer of the cheek which has developed upon the basis of leukoplakia can be destroyed (after preliminary irradiation and biopsy) completely by electrocoagulation. On the other hand, if one is dealing with a large bulky cauliflower growth inside the cheek, it can be best treated by preliminary surface application externally with either high voltage x-rays or radium packs over the cheek and neck, followed by the insertion of radium needles with approximately 1 mg. for each 1 cm. of tumor tissue, leaving it in place for from five to seven days. Generally, 1,800 r is given, with high voltage x-rays or their equivalent, with radium, before the insertion of the needles. Further external irradiation is given according to indications, if necessary, after the needles are removed.

Cancer of the tongue gives more variations as to the problem of technic and management than any other cancer about the mouth, because there are more variations possible as to location, extent, duration, and degree of malignancy, as well as variations in the etiology, and because of almost certain metastasis. Baensch's material showed 65 per cent to be inoperable, chiefly because of associated metastasis. It is shown that 60 per cent of all tongue cancers, and, in some reports, 89 per cent, are inoperable from the very beginning. An accurate statistical analysis would demand a list of each of the above mentioned factors as well as the technic used in each. One would have to add the factor of associated syphilis in each group, for the diagnosis is always more difficult and the prognosis always worse when syphilis is present. A serologic test should always be made in clinical cancer of the tongue, but should never replace nor delay a biopsy. These diseases are frequently present together. Hayes E. Martin says, "About one-third of all patients with tongue cancer also have syphilis."

In general, cancers involving the anterior portion or margins of the tongue are more easily treated and best results are obtained in these regions. The dorsal and posterior lesions are technically more difficult to treat and give the poorest results. Some of the anterior primary lesions can be treated by surface applications of radium, or by localized treatment with high voltage x-rays, using the shock-proof outfit and the localizing tubes, as recommended by H. E. Martin, or one can destroy the lesion by inserting 10 mg. radium needles placed through and around the cancer, about 1 cm. apart, leaving them in place for from four to six hours, depending upon the amount of associated surface irradiation. Some of

these anterior lesions which contain much dense fibrous tissue are best removed by electro-surgery, but when this procedure is used on any large lesion of the tongue, there must be a preliminary ligation of the lingual artery.

Marginal or sublingual cancers can not be easily treated by surface applications of radium, because of the danger of damage to the mandible. After preliminary external irradiation, it is probably best to insert the small quantity radium needles (1 mg. per cm.) and leave them in place for from five to seven days. At times, when the lesion is dense and fibrous, it is best removed by electro-surgery, keeping away from the mandible. If one destroys the periosteum of the mandible by electro-coagulation, necrosis will result.

When treating cancer of the dorsum or base of the tongue, one should use surface applications with highly filtered radium—2 mm. of platinum—together with external cross-firing with high voltage x-rays (200 kv. with 2 mm. Cu filter, or 400 kv. with 7 mm. Cu filtration. This should be given by the prolonged fractional dose method, giving 200 r per day to the limit of normal tissue tolerance. Then, unless the lesion has responded sufficiently, long radium needles should be inserted into the base of the cancer through the skin of the submaxillary region above the hyoid bone.

Cancer of the gums and alveolar process has responded best, in my experience, by the use of surface applications inside of the mouth and radium packs externally at a distance of 4 cm., filtered through 2 mm. of platinum. If the cancer extends down to the inferior dental artery, surgical resection after preliminary x-ray treatment will probably be best.

Cancer of the roof of the mouth has seemed to me to be more radiosensitive. In this group, I generally depend upon surface application of highly filtered radium within the mouth and cross-firing with high voltage x-rays.

Metastases from Cancer of the Lip.—The spread of cancer or metastasis is, after all, the most serious problem in dealing with cancer of the lip or mouth. The earlier a cancer of the lip is treated the less likelihood is there of metastasis, but no one can be sure of the absence of metastasis at any time. This fact has led me to give prophylactic irradiation with x-rays over the mental, submental, and submaxillary regions, even in early cases (not more than 1.5 cm. in diameter) without palpable lymph nodes. This has given me 98 per cent of five-year cures. In the 2 per cent

TABLE II.—CANCER OF THE MOUTH

	Five-year Results: Cases seen up to July 1, 1934						Three-year Results: Cases treated up to July 1, 1936						Cases first treated since July 1, 1936			Total Cases
	Alive	Dead due to cancer	Percentage of survivals	Died of intercurrent dis.	Not traced	Total	Alive	Dead due to cancer	Percentage of survivals	Died of intercurrent dis.	Not traced	Total	Alive	Dead of cancer	Total	Total, all cases
Cancer of tongue	42	112	27%	9	14	177	51	114	31%	8	13	186	4	2	6	192
Cancer of cheek (buccal mucosa)	21	34	38%	3	11	69	32	28	53%	1	9	70	1	0	1	71
Cancer of tonsil	8	22	27%	1	4	35	11	24	31%	1	4	40	2	0	2	42
Cancer of lower jaw	13	31	29%	1	11	56	14	30	32%	1	11	56	0	1	1	57
Cancer of palate and pharynx	15	39	28%	7	15	76	19	41	32%	4	14	78	4	1	5	83
Cancer of floor of mouth	4	16	20%	1	4	25	7	16	30%	0	4	27	2	1	3	30
Total	103	254	29%	22	59	438	134	253	35%	15	55	457	13	5	18	475

in which metastasis developed at a later date, through an oversight, the patients did not receive the associated x-ray treatment and only the local lesion was treated. This naturally has led me to have a great deal of faith in this associated treatment of the regional lymphatics.

I realize fully, from all our experiences and investigations, that actual cancer involvement is not likely to be destroyed by such an amount of irradiation, and a considerable number of our most experienced cancerologists do not consider it efficient, necessary, or advisable. Their arguments almost convince me, and yet, when the individual patient comes to my care, based upon my own past experience, I feel that I am asking the patient to take an unnecessary risk if I avoid giving this radiation. It may be that this moderate amount of radiation is of prophylactic value because of its effect on normal tissue in preventing spread of the disease, or it may be that cells which have just been implanted and not yet developed into definite tumor tissue may be destroyed. Furthermore, Dr. Ewing is of the opinion that inflammatory processes seem to pave the way for the development of cancer and extension into the lymphatics. It is well known that a moderate amount of irradiation hastens the healing of an inflammatory process. It may be that my moderate amount of radiation is helpful in a prophylactic sense by acting in this way. In a letter to me dated July 31, 1939, Dr. Ewing says:

"It is my belief that inflammatory involvement of lymphatics paves the way for cancer in general. It widens the circulatory paths, and, of course, the infection of the primary tumor which causes the inflammation tends to accelerate the local growth. I do not know of any article in which I have elaborated this statement. We agree that routine block dissection is unwise."

Because of the possibility of early and unrecognizable metastasis some surgeons have recommended routine block dissection. Kennedy says:

"Theoretically, at least, it is possible for one or a few metastatic cells to be present in a regional lymph node and impracticable for the pathologist to find them. It is not proper to neglect doing a regional node dissection and allow such deposits to grow."

McMahon states:

"In our present state of knowledge, surgical excision is the only efficient form of attack, and should be carried out in all cases . . . . . Removal of the lymph glands should include the excision of the submental and submaxillary groups, together with the glands of the jugulodigastric angles of both sides. Should these glands be found on routine pathological examination to be involved with metastases, removal of the deep cervical glands should be carried out at a second operation."

This routine block dissection of the lymphatics in early cancer of the lip I believe is inadvisable because: (1) I have been able to get 98 per cent cures without such dissection but with prophylactic irradiation; (2) it has been shown that only about 20 per cent of these earlier primary lesions (1.5 cm.) develop metastasis even with no treatment over the lymphatics, and without block dissections; (3) it involves a serious operation, scarring, and often deformity about the neck, edema and much discomfort, and also, because the records show (Kennedy) 11 per cent mortality from the operation. Fischel reports 21 per cent mortality when intra-oral operation was performed at the same time on clinic cases but only 5.7 per cent when the dissection was performed after the primary lesion was healed. Now, if we subtract 11 per cent from the 20 per cent of patients who are likely to have involvement, it leaves only 9 per cent whose lives are possibly saved by such a procedure, if successful. Fortunately one can at least reserve block dissection for those who have palpable lymph nodes, and then 11 per cent of the 20 per cent gives approximately 2 per cent operative mortalities. On account of the fact that only 20 per cent of these early cases are likely to develop metastases, it would be fair to argue that it is, therefore, unwise to give irradiation to the regional lymphatics in these early lesions. However, until some other method produces 98 per cent cures in these early cases, I am

inclined to continue with the prophylactic irradiation.

Fear of operation is the most common cause of delay in consulting a physician. Block dissection intensifies this fear wherever the patient goes, even if he recovers. I believe it can be avoided in cancer of the lip.

Metastasis from cancer within the mouth is even more serious and especially when dealing with cancer of the tongue. The continual movement of the tongue in speaking, swallowing, chewing, etc., together with the rich distribution of lymphatics, makes the likelihood of extension of the disease very great, and such distribution takes place early. Furthermore, it is apt to involve both sides. Block dissection of both sides of the neck is a serious operation and is generally inadvisable. The indications and the contra-indications for such block dissection have been given by Duffy, as follows:

"For a case to be operable, all the indications must be present. Any one contra-indication completely excludes radical neck dissection and is a recommendation for irradiation:

"NECK DISSECTION

Indicated	*Contra-indicated*
1. Primary lesion is controlled;	1. Primary lesion is uncontrolled;
2. Primary lesion is limited to one side of oral cavity;	2. Primary lesion extends to or beyond the midline of oral cavity;
3. Primary lesion is shown to be of highly differentiated cell type;	3. Primary lesion is shown to be of undifferentiated cell type;
4. Cervical metastases are present and limited to one group of nodes or nodes in two contiguous cervical triangles;	4. No metastatic nodes are present;
5. Capsule of nodes is not infiltrated by carcinoma;	5. Capsule of node is infiltrated by carcinoma;
6. Opposite side of neck is free of metastases;	6. Cross or bilateral cervical metastases are present;
7. Patient is in good general condition.	7. Distant metastases are present;
	8. Patient is in poor general condition."

It has been my practice to treat by irradiation even the cases with lymphatic involvement, using either continuous radium packs over a period of about twenty-five days, or using high voltage x-rays, either 200 or 400 kv., and the equivalent of either 2 mm. or 7.75 mm. of copper, respectively, cross-firing carefully through the palpable lymph nodes into the primary lesions and supplementing the treatment with either surface applications of radium to the local lesion of the tongue, or the insertion of radium needles into the primary lesion. Then commonly after the preliminary surface irradiation to the glands, radium needles are inserted into the palpable lymph nodes. I have had some satisfactory results in this type of case, even in that group in which the cancer has broken through the capsule of the gland, and in which the metastasis was fixed with the surrounding tissues. Up to the present time, I have never punctured a blood vessel. It does seem to me that this insertion through the skin is possible when one can palpate the affected lymph node which is commonly fixed and will, therefore, hold its position. It is my practice to place a needle directly into the center, which gives me my fixation point, and also my location for the subsequent needles, and then I commonly put three or more surrounding this center point at a distance of approximately 1 or 1.5 cm. I have had some good results in these cases with the use of 10 mg. radium needles left in place for from four to six hours, but it is my impression that it is better to use the smaller quantity radium needles and leave them in place for a longer time, using 1 mg. per centimeter of effective needle length and giving the equivalent of 120 to 144 mg.-hr. per cubic centimeter of cancer tissue in the lymph node. I say 120 to 144 mg.-hr. because that amount will be governed somewhat by the amount of preliminary and subsequent surface irradiation that has been given, or is to be given. For example, if one has given through the surface the equivalent of from 4,000 to 4,500 r, then probably 120 mg.-hr. would be sufficient, or 40 mg.-hr. if 10 mg. needles are used. If, on the other hand, one has given only from 2,500 to 3,000 r, then it is probably advisable to give a treatment with the radium needles equivalent to 144 mg.-hr. per c.c. with the small needles or 60 mg.-hr., using 10 mg. needles. For example, if one

uses needles with the equivalent of 1 mg. of radium in 1 cm. of active needle length for 1 c.c. of cancer tissue and leaves it in place four days, there would be 96 mg.-hr. per c.c., or if one leaves it in place for six days, 144 mg.-hr. per c.c. If, on the other hand, one is using 10 mg. units, there is a more immediate destructive effect and the equivalent would be to leave the needles in place approximately 60 hours by comparison.

We now know that the fully differentiated type of carcinoma is relatively radioresistant, and, therefore, the slowly reacting radium over a period of from four to six days will probably be more effectual. C. L. Martin has shown some fine results in individual cases involving large primary lesions and large metastatic lesions, using small quantity radium needle insertion, leaving each in place seven days. He has applied the radium needles for the most part at the beginning of his treatment, and then followed with surface irradiation, using highly filtered high voltage roentgen rays. It has been my practice to give about half of the surface irradiation before inserting radium needles, and then giving the other half after the insertion of radium needles. Theoretically this seems to me to be a better procedure, because one eliminates whatever danger there is of spreading disease by radium needle insertion, because one has, by this preliminary surface irradiation, devitalized to a considerable extent these carcinoma cells. The needles bring about an intensive local destructive effect upon the cancer cells with less damage to the surface, and then the subsequent surface irradiation, which is continued perhaps during a week or two following the radium needling, takes care of any attempt at recovery of the affected cancer cells.

The treatment of cancer of the mouth and lip has been discussed with regard to other details in previous papers.

SUMMARY

Cancer of the lip can be prevented in practically all cases by treating skillfully the lesions that frequently precede cancer. By making an effort to treat such lesions, many early cancers will also be reached and cured.

Cancer of the mouth can be prevented by treating any leukoplakia as soon as it develops, destroying any papilloma, treating any lesion of the mucous membrane, such as erosion, ulcer, irritation, or induration. Electro-desiccation is valuable in these precancerous conditions. The treatment of cancer of the lip and mouth must include both the local or primary lesion, and the regional lymphatics.

Irradiation is the preferable treatment for cancer of the lip and mouth.

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THE USE OF ZINC PEROXIDE IN INFECTED TUMORS AND RADIATION NECROSIS

A REPORT OF CASES, WITH TECHNIC[1]

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From the Head and Neck Service of Hayes E. Martin, M.D.

THE mouth contains a variety of anærobic and micro-ærophilic organisms which under normal conditions are harmless saprophytes. However, when oral tissues become devitalized or diseased these same bacteria may cause an infection which is painful, debilitating, and resistant to treatment. The condition is characterized by a fetid odor and necrosis of tissue to form thick adherent slough, without a great deal of purulent discharge, unless there is secondary deep abscess formation.

This type of infection so frequently accompanies tumors of the oral, nasal, and paranasal cavities that it has become one of the major problems in their management. The complication may occur in the primary tumor, in a post-operative cavity or surgical defect, or in an area of necrosis resulting from roentgen or radium therapy. Once the process has gained a firm foothold, it is difficult to overcome by ordinary measures. Instrumental removal of slough is inadequate. The usual oxygenic agents such as sodium perborate, potassium chlorate, and hydrogen peroxide are not efficient because of their short period of action. Dakin's solution, although more effective, also acts for only a short period of time and is irritating to tissue.

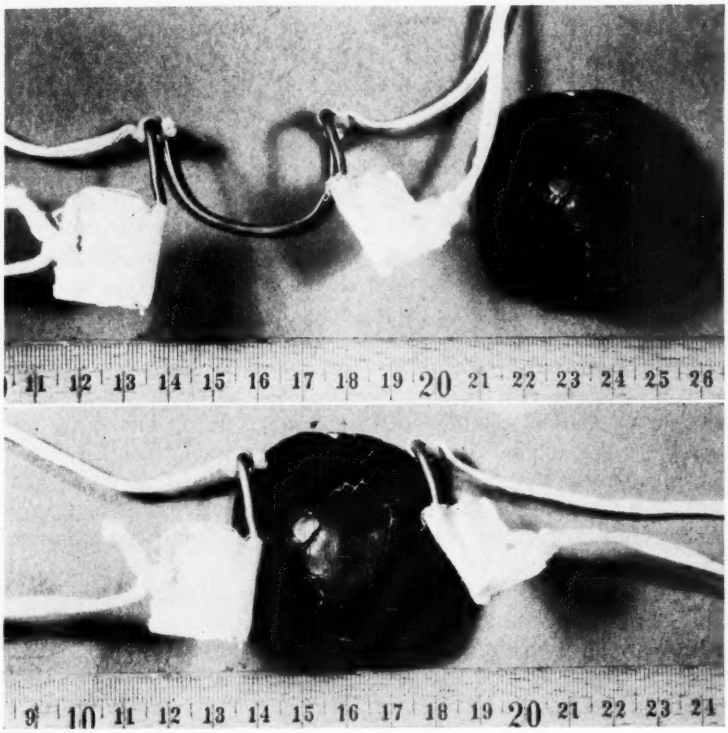
Reports in the literature of the results obtained by the use of zinc peroxide in the treatment of surgical anærobic infections suggested a new way of treating this complication of cancer. For the past year we have used zinc peroxide on the Head and Neck Service of the Memorial Hospital in an effort to determine its clinical value in this type of lesion.

[1] Read in part at the Third International Cancer Congress, Atlantic City, N. J., Sept. 13, 1939.

According to Meleney, zinc peroxide was first made by Thenard in 1810, and its use as an antiseptic first suggested by Elias (3) in 1903. Shortly thereafter, reports on its effect in surgical infections and other conditions were made by several authors (Mayer, 8; Paucot, 15; Hochstetter, 5; Chaput, 1; Vanverts, 18, and Laurent, 7). However, its use soon fell into disrepute and it was not until 1935, when Meleney's first work (9) was published, that zinc peroxide became widely known.

This author was studying chronic ulcerative, burrowing, non-gangrenous ulcers of the abdominal wall caused by the micro-ærophilic hemolytic streptococcus. He believed that these organisms would be inhibited by a highly oxygenated environment and consulted Dr. Hans Clarke, Professor of Biochemistry at the College of Physicians and Surgeons, requesting a non-toxic peroxide giving off oxygen slowly over a period of hours or days. Dr. Clarke suggested zinc peroxide, a quantity of which had been sent him for experimental purposes. Thereupon, three of these cases were treated with zinc peroxide, with rapid subsidence of the infection, followed by prompt healing. Meleney also found that cultures of this organism were killed by the addition of zinc peroxide. Further studies (10, 11) showed the preparation to be efficacious in infections caused by other anærobic organisms. In 1937 (12), he advocated its use in the treatment of mouth infections, and stressed its value as a prophylactic mouth wash prior to tonsillectomy and dental extractions. In a later paper (13), he reviewed the bacteriologic flora of the mouth, and presented cases of cellulitis following dental extractions in

which the use of zinc peroxide had been beneficial. The same author (14) has more recently reported the combined use of zinc peroxide and sulphanilamide, but the results of the combination have not been conclusive.



Figs. 1-*A* and 1-*B*. Appliance used for holding zinc peroxide dressings in place during treatment of lesions of antrum, palate, or upper alveolar ridge. It consists of a plate of dental compound molded to fit the patient's mouth, and held in place by a frame of heavy iron wire.

Wintrup (19), in 1938, reported excellent results in 33 cases of mouth and dental infections and two cases of radiation necrosis treated with zinc peroxide. Pennoyer (16) reported a case of chronic undermining ulcer of the jaw and neck, similarly treated with very good results.

PROPERTIES OF ZINC PEROXIDE

1. *Chemical Properties.*—Zinc peroxide is a white powder containing from 45 to 50 per cent ZnO_2, from 35 to 40 per cent ZnOH, and from 10 to 15 per cent $ZnCO_3$. It has the property, upon being mixed with water, of forming a suspension which liberates oxygen slowly over a long period of time. Heating the powder in a dry oven at a constant temperature of 140° C. for four hours sterilizes the preparation and in some way activates it so that the liberation of oxygen is increased. The amount of oxygen given off by a suspension of unheated powder is inadequate for clinical use.

An incidental property of zinc peroxide is that it casts an opaque shadow on a radiographic film. This characteristic is occasionally of use in determining the extent of a cavity which is being treated.

2. *Toxic Properties.*—Zinc peroxide has no harmful effect upon living tissue, and is

not to be confused with the caustic zinc chloride. With the exception of the latter, the continued administration of zinc salts has no effects in man, except those of disordered digestion and constipation (2). We have observed neither of these symptoms in our series of cases. The unavoidable swallowing by patients of small amounts of zinc peroxide has had no harmful results. The preparation is almost tasteless and there are few complaints about its intra-oral use. A few patients have noted a moderate burning sensation, but others have remarked that it has a soothing effect. The theoretical possibility of the formation of zinc chloride in the stomach due to reaction of zinc peroxide with the gastric hydrochloric acid may be discounted. Occasionally, during the course of treatment, hemorrhage has occurred in the affected area. This has been due to the separation of slough causing exposure of underlying blood vessels, and not to any direct action of the zinc peroxide on the living tissue.

3. *Bactericidal Properties.*—Zinc peroxide has been demonstrated to be an effective agent in killing anærobic bacteria in wound infections. Johnson and Meleney (6) have found, moreover, that its addition to cultures of various ærobic, anærobic, and micro-ærophilic bacteria causes death of the organisms *in vitro*. It has also been shown to be an efficient means of controlling mouth infections which are most frequently caused by one or more of the following anærobic organisms: anærobic nonhemolytic streptococci; *Treponema microdentium; Treponema macrodentium;* fusiform bacilli and spirilla (Vincent's organisms, 13).

In comparison to other preparations which have been used in the treatment of intra-oral infections, zinc peroxide possesses several advantageous qualities. The most widely used and efficient of these agents are Dakin's solution and hydrogen per oxide.

The action of Dakin's solution is thought to be due chiefly to the sodium hypochlorite which it contains. While some of its disinfecting value may be due to the vigorous oxidizing action resulting from its decomposition, there is much evidence to show that the chlorine may attack the bacteria directly. Dakin's solution is an efficient antiseptic and a fairly good deodorizing agent. Its disadvantage is that it exerts its action over a short period of time. Upon application, the reaction is instantaneous and, having taken place, no further action is shown. Therefore, to obtain the maximum effect it must be used at frequent intervals. The extremely unpleasant taste and often painful reaction make frequent applications impractical for use in the mouth. Furthermore, Dakin's solution has a varying but definite caustic effect on normal tissues.

Hydrogen peroxide owes its antiseptic action of the liberation of nascent oxygen. Its penetrating power is less than that of Dakin's solution but it has no harmful effect on normal tissues. Here again, however, the liberation of oxygen occurs immediately on contact with organic matter and the hydrogen peroxide is quickly reduced and weakened.

Similarly, zinc peroxide acts through liberation of nascent oxygen. In contrast to hydrogen peroxide, however, zinc peroxide liberates its oxygen slowly over a period of 24 hours or more. With careful application its action will penetrate to the depths of a lesion. Due to its prolonged action, only one or two treatments a day are necessary. Unlike Dakin's solution, it is almost tasteless, and has no caustic effect on normal tissue. Its deodorizing action is highly efficient and far superior to either of the other two antiseptics.

The one disadvantage to the use of zinc peroxide is the tendency of a suspension of the powder to dry and form a hard cake. This difficulty can be largely circumvented by careful sealing-off of the preparation, as will be discussed more fully below.

In several cases prompt recurrence of the active tumor has been noted. However, we have no evidence that zinc peroxide has any stimulating effect on tumor tissue. The recurrences are probably noted sooner because they occur in a clean, healthy granulating surface.

INDICATIONS FOR USE

Meleney (10) cautioned against the use of zinc peroxide in surgical infections in general, without preliminary bacteriologic study to determine whether or not the causative organisms were of the anærobic type. However, with the type of infection which occurs during therapy of cancer of the mouth, nasal cavity, and paranasal sinuses, the clinical appearance is sufficiently diagnostic. Cultures in the past have shown these infections to be anærobic in the great majority of cases. The characteristic fetid odor and the thick grayish slough covering the surface of the lesion are unmistakable.

Our indications for use of zinc peroxide in primary tumors, post-operative defects, and areas of radiation necrosis have been the appearance of the above mentioned signs. These conditions are generally accompanied by swelling and redness of the surrounding tissues and, in some instances, by complaint of severe pain in the affected region. Rise of temperature is variable. In some cases there is a small, irregular elevation of temperature while in others it may be normal. In acute or widespread infection there is often considerable fever.

More recently, in post-operative cases, we have applied zinc peroxide routinely upon removal of the operative packing, without waiting for signs of infection. The preparation has also been used as a mouth wash pre-operatively when extensive surgery of the oral cavity has been contemplated.

In short, in the field with which this paper is concerned, we believe that the use of zinc peroxide is indicated at the first clinical manifestation of infection; and that in operative cases it should be used pre-operatively and post-operatively as a prophylactic before signs of infection occur.

TECHNIC

The technic we have used closely follows that described by Meleney. The powder is activated by heating in a dry oven at a constant temperature of 140° C. for four hours. The advocated method is to heat the zinc peroxide in small quantities shortly before using. Because of the volume of cases being treated at one time at our hospital, we have found this impractical, and have heated it in one pound quantities in large petri dishes. The zinc peroxide thus treated remains active at least three weeks after heating, and should not be reheated. Preparations which are not of medicinal grade are unsatisfactory.[2]

In the past, different preparations of zinc peroxide have varied in their oxygen-liberating capacity. Because of this fact, a simple test of activity has been devised by Meleney. A small amount of the powder is placed in a test tube of water and shaken so that an even suspension is produced. If the preparation is active, the suspension will settle rapidly, leaving a clear supernatant fluid. Within half an hour the sediment will begin to become flocculent and small gas bubbles may be seen escaping to the surface. In 24 hours the volume of the sediment will be greatly increased and markedly flocculent; much will have floated to the surface. If the preparation is inactive, the sediment will settle more slowly, leaving a cloudy supernatant fluid. Few gas bubbles will be apparent and the sediment will remain closely packed in the bottom of the test tube.

At the time of application the activated powder is mixed with water to form a suspension the thickness of 40 per cent cream. If the area to be treated is on the skin surface, it is coated with the suspension, covered by gauze similarly soaked, and sealed-off from the air with layers of vaseline gauze or boric ointment strips. With intra-oral treatment, adequate sealing-off and accurate application is more difficult. The material is introduced into the depths of the lesion by means of a Kaufmann-Luer syringe with a semi-rigid nozzle about 4 in. in length. Over this is placed gauze

[2] The preparation we originally used was manufactured by the E. I. duPont Co., and designated as *medicinal grade*. This same grade has recently been put on the market by Merck & Co., under the title of Z.P.O.

packing or a sponge soaked in zinc peroxide suspension. Vaseline gauze is used to pack off the treated area. For lesions of the palate, floor of the mouth, upper alveolar ridge, antrum, etc., moulages and dental plates of rubber compound can be constructed to hold the vaseline gauze firmly in place. The plate or moulage is itself held in place by the impression in the rubber or by a special device similar to the one shown in Figure 1. Rapid drying out and caking of the zinc peroxide cause diminution in the amount of oxygen liberated and make the removal of the material more difficult. It is important, therefore, to seal-off the preparation adequately with vaseline gauze.

Ordinarily the zinc peroxide dressings are left *in situ* for 24 hours if this is made practicable by the type and location of the lesion. Certain intra-oral tumors require more frequent care. If the packing interferes with eating, it is removed before, and replaced after, meals; or packed after the evening meal and left in place over night. Each time the packing is changed the residual zinc peroxide is removed by means of hydrogen peroxide or saline sprays.

Because of the possibility of secondary radiation from the zinc peroxide we have made a practice of removing the packing from patients undergoing roentgen therapy before they receive their treatments. In addition to its use as a packing which is left in place, zinc peroxide has been used as a mouth wash. For this purpose the powder is mixed with water in a proportion of 1:4 and used at from two to four hourly intervals.

TABLE I.—ZINC PEROXIDE SERIES

Location	Cases	Group 1, Infected Tumors	Group 2, Radiation Necrosis	Group 3 (Prophy.)	Post-operative (Infected)
Tongue—M.	10	1	6	2	1
Alveolar ridge	4	0	2½*	½*	1
Skin—face, neck	6	2	2	1	1
Antrum	5	0	2	2	1
Floor—mouth	4	1	3	0	0
Tonsil	4	0	2	1	1
Nasal cavity	4	0	1	1	2
Buccal mucosa	3	1	1	1	0
Extrinsic larynx	2	0	1	0	1
Tongue—N. M.	1	0	0	1	0
Palate	5	0	0	5	0
Maxilla—M.	1	0	0	1	0
Maxilla—N. M.	1	0	0	1	0
Mixed tumor—parotid	1	0	½*	0	½*
Mandible	1	0	0	1	0
Total	52	5	21	17½	8½

* Cases marked "½" represent those who received treatment during two different periods and thus fall into more than one group.

Variations in technic have been used by others. Wintrup advocated making a thick paste and applying it to the lesion with the fingers. Pennoyer mixed the powder with hydrogen peroxide instead of water. We have tried this method and found that in some cases it seems to diminish the tendency of the suspension to dry and harden. However, the difference is not great enough to warrant its routine use. Wright (20), in treating osteomyelitis, used a mixture of cod-liver oil and zinc peroxide. Meleney tried mixing the powder with oil and with grease to prevent caking, but found that it lessened the activity.

Recently, instead of mixing the powder with water we have tried mixing it with a 2 per cent solution of a high viscosity polyvinyl alcohol, which was supplied to us for experimental purposes. With this preparation there is less tendency of the zinc peroxide toward caking, and the oxygen out-

put over a 24-hour period seems to be undiminished.

DISCUSSION

Thorough bacteriologic investigations of mouth infections have been reported by others and in our observations we made no attempt to study the specific action of zinc peroxide on the bacteria. Our primary interest was to observe the clinical results of this form of therapy and our conclusions are based on two observations: (1) an improvement in the appearance of the lesion, and (2) subjective local and systemic improvement on the part of the patient.

Fifty-two patients have been selected from a much larger group treated during the past nine months. These cases included malignant tumors of the tongue, tonsil, alveolar ridge, buccal mucosa, floor of the mouth, palate, maxilla, antrum, nasal cavity, extrinsic larynx, and skin of the face and neck. There were also non-malignant lesions of the tongue, maxilla, mandible, and parotid gland.

For the purposes of this report the cases are classified and divided into three main groups, according to the clinical stage of the infected tumor when first treated with zinc peroxide.

Group I includes the primary infected tumors;

Group II, the cases of infected radiation necrosis; and

Group III, the post-operative cases. The latter group is subdivided into (*a*) those in which the preparation was used prophylactically and (*b*) those in which infection was already present.

Table I shows the distribution of cases in these three groups. In this series of patients zinc peroxide found its greatest use in the treatment of infections occurring in areas of radiation necrosis. However, the most gratifying results were obtained in the post-operative prophylactic group.

The results of this treatment have been uniformly good in controlling anærobic infection. In some cases the improvement has been dramatic, while in others the response has been slower. In the very few in which satisfactory progress was not made, it could generally be attributed to failure of co-operation on the part of the patient, or his inability to appear for regular treatments.

A feature of all the cases treated was the marked diminution of the offensive odor within 24 hours. As a rule the odor disappeared completely by the second or third treatment. The slough separated readily and could be removed by sprays or gentle instrumentation. Within two or three days clean granulations appeared at the base of the areas treated and there was subsidence of surrounding soft-tissue swelling and inflammation.

The duration of treatment has varied with the extent of the infection. Sometimes three or four treatments have sufficed. In other cases one or two weeks of regular applications have had to be given, followed by weekly or bi-weekly packings for several weeks. If there has been cellulitis of the surrounding tissues with deep abscess formation, surgical intervention has, of course, been necessary. In superficial infections the zinc peroxide alone has been adequate.

The secondary infections of primary tumors have shown a prompt disappearance of slough and odor after zinc peroxide therapy. The lives of patients with advanced and uncontrollable cancer have been much happier by this form of therapy in spite of their progressively weakened condition.

Infections in areas of radiation necrosis as a rule have not responded as quickly as post-operative infections in non-radiated tissue. However, the results from zinc peroxide therapy in this group of cases have been better than those of any other method of treatment previously used in this clinic. Many of the patients with radiation necrosis had carried infections for several months prior to the use of zinc peroxide. When the affected areas were small the majority of cases have healed entirely after two or three weeks of treatment. Those with more extensive necrosis have required intermittent treatment over a period of months for recurrent infection.

Fig. 1-*C*. A patient with a large infected cavity secondary to bilateral antrotomy and resection of nasal bones, showing zinc peroxide dressing held in place by the special appliance.

In the post-operative prophylactic group the zinc peroxide suspension has generally been applied immediately following the removal of the original packing inserted at the operating table. In cases in which there was thought to be danger of hemorrhage, treatment was deferred for another 24 to 48 hours. For the most part the operation performed in this group has been: resection of the palate or mandible; partial or complete glossectomy; or an operative procedure on the nasal or paranasal cavities in which a large defect has resulted. Without exception, these cases which were treated early with zinc peroxide have remained free of local infection during the healing process. Convalescence has been relatively afebrile and the patients have been spared the fetid odor and pain which so often are sequelæ of open operations within the oral cavity.

In those cases in which infection was already present post-operatively as evidenced by slough, foul odor, and redness and swelling of the surrounding tissues, the use of zinc peroxide brought about prompt improvement and healing. The initial good results in this group have led at the present time to the routine use of zinc peroxide prophylactically following operations of the type mentioned above.

CASE REPORTS

Case 1. W. B., 65-year-old, white English male. Carcinoma, skin of face (nose). Microscopic diagnosis: squamous carcinoma, Grade III. First seen on Oct. 5, 1938, with a lesion of the left aspect of the nose near the naso-labial fold. Because of repeated negative biopsies, roentgen therapy had been delayed, but it had been given from Jan. 12, 1939, to Feb. 8, 1939. On Jan. 21, 1939, the patient was forced to leave his boarding house because of the foul odor from the tumor, and he was admitted to the hospital the same day. On admission, he had very foul-smelling deep ulceration filled with slough on the left aspect of the nose. There was marked induration of the surrounding tissues, erythema of the skin, and edema of the left eyelids. The crater was packed with zinc peroxide immediately and sealed over with vaseline gauze, extending out onto the surrounding skin. The odor almost entirely disappeared in 24 hours and the base of the ulceration was clean except for one area of slough. He was packed once daily for eight days, the pack being removed for roentgen therapy. He was discharged on the eighth day, returned to the boarding house, and received daily packing in the out-patient clinic for six more days. Five days after beginning of the zinc peroxide packing, the lesion was free of slough and remained clean without odor. On March 21, 1939, he developed an abscess at the upper angle of the defect, which was incised. On May 2, 1939, there appeared evidence of extension of the disease upward from the upper angle of the defect. On May 5, 1939, he was admitted to the hospital, where the crater was packed with zinc peroxide every 24 hours for 12 days. Disappearance of the odor and some diminution of the slough resulted, but rapid extension of the tumor followed. On May 9, 1939, roentgen therapy was resumed. On May 26, 1939, he developed erysipelas of the face. This subsided with sulphanilamide therapy. On June 5, 1939, he was transferred to a nursing home where, on June 9, 1939, he died.

Case 2. C. M., 89-year-old, married, white, Italian male. Carcinoma of the buccal mucosa. Microscopic diagnosis: squamous carcinoma, Grade II+. First seen

Fig. 2.

Fig. 3.

Fig. 2. Case 1. Photograph taken Jan. 6, 1939, after roentgen therapy had been instituted and just before zinc peroxide treatments were begun. The ulceration is filled with foul-smelling slough and there is considerable inflammation of surrounding tissues.

Fig. 3. Case 1. Photograph taken Jan. 30, 1939, after zinc peroxide therapy. There has been increase in size of the cavity but there is no evidence of infection. The edema of the face has disappeared.

on April 7, 1939, with an ulcerating, foul-smelling, extensive lesion of the left buccal mucosa with cervical metastases. He was given roentgen therapy with only slight regression. On April 16, 1939, mouth washes with zinc peroxide were used, with only slight improvement. On April 19, 1939, we began packing with zinc peroxide daily for five days, sealing-off the mouth of the crater with vaseline gauze. The odor completely disappeared and the lesion appeared clean at the end of the course of treatment. Since that time the patient has become too weak to come in regularly, but has been packed with zinc peroxide every one or two weeks. The lesion has been much cleaner and the patient more comfortable. The tumor is now progressing rapidly. Extensive roentgen therapy has not been given because of the advanced stage of the disease and the age of the patient.

Case 3. M. H., 60-year-old, single, white, American female. Carcinoma of the left nasal cavity and antrum. Microscopic diagnosis: adenocarcinoma, Grade II. First seen on Feb. 15, 1937, when she was given roentgen therapy and radium capsule with resultant good regression. Recurrence was noted on July 6, 1938, and on July 15, 1938, bilateral ligation of the facial and external carotid arteries was done, followed by left antrotomy. Another recurrence was seen in the left antrum on Sept. 2, 1938. On Sept. 15, 1938, ligation of the left external carotid artery and cautery excision of the recurrence was performed. There was still another recurrence on Jan. 25, 1939, high in the antrum, for which exenteration of the orbit was done on March 22, 1939. By March 24, 1939, the post-operative cavity was lined with thick, foul-smelling slough and the patient complained of exquisite pain. The cavity was packed daily with zinc peroxide for 19 days. The odor and much of the slough disappeared entirely after four days of treatment. The cavity has remained clean, with no evidence of recurrence to date.

Case 4. C. M., 52-year-old, single, white, American male. Carcinoma of the right antrum. Microscopic diagnosis:

Fig. 4. Case 3. Photograph taken after completion of zinc peroxide treatment. Cavity created by antrotomy and exenteration of orbit can be seen. Its lining is clean and granulating and the soft-tissue inflammation has subsided.

squamous carcinoma, Grade I. He was first seen on Nov. 19, 1934, with leukoplakia of the hard palate which was cauterized but recurred. In September, 1937, he developed an abscess of the right maxilla and, on extracting the teeth (Sept. 4, 1937), carcinoma of the antrum was found. This was treated with roentgen therapy with excellent regression. The patient later developed necrosis of the maxilla which sequestrated. On Jan. 14, 1939, necrotic bone was removed and a right antrotomy performed. Within 48 hours the patient developed edema and redness of the face; the cavity became lined with fibrin and rather foul-smelling material. On Jan. 18, 1939, four days post-operative, the cavity was packed with zinc peroxide, sealed-off with vaseline gauze which was held in place by an upper plate made of dental compound. The patient liked wearing the plate because it aided him in swallowing and articulation. After one treatment, the edema of the face disappeared and the cavity was entirely clean, showing fresh pink granulations and clean bone. There was no odor. The cavity was packed in the evening on seven consecutive nights, the packing remaining in place over night. The wound stayed clean and healed rapidly. The patient was discharged from the hospital on the seventh post-operative day. Following discharge, the cavity was packed once weekly in the out-patient clinic for five treatments. Patient gained weight. Since that time the patient has had to have removal of small pieces of dead bone from time to time but the antrotomy defect has stayed clean.

Case 5. J. D., 74-year-old, white, married, American male. Diagnosis: (1) carcinoma of the extrinsic larynx (microscopic diagnosis: epidermoid carcinoma, Grade II); (2) carcinoma of the tongue (microscopic diagnosis: squamous carcinoma, Grade II+). First seen on Jan. 6, 1939, with carcinoma involving the left arytenoid, and was given roentgen therapy. On Jan. 25, 1939, an emergency tracheotomy was performed because of edema of the larynx. Foul-smelling slough subsequently developed in the tracheotomy wound, with marked surrounding soft-tissue inflammation. He received packing twice daily with zinc peroxide for three days with resultant clean granulations and complete subsidence of the inflammation, following which the wound healed rapidly. Careful sealing-off of the preparation was especially important in this case, in order to prevent aspiration of the material. On April 5, 1939, the patient developed a small ulcerated area at the base of the tongue which was found to be carcinoma. Gold filtered radon seeds were inserted into the lesion and the ulceration was kept clean with intermittent zinc peroxide packing. However, the tumor progressed rapidly, the patient soon became too weak to come in for treatments, and died on July 24, 1939.

Case 6. W. L. B., 76-year-old, widowed, white, American male. Diagnosis: carcinoma of the floor of the mouth. Microscopic diagnosis: squamous carcinoma, Grade II. He was first seen on Feb. 28, 1938, with tumor involving the floor of the mouth near the left lateral border of the tongue. He was given roentgen therapy and gold filtered radon seeds were inserted with subsequent complete regression of the lesion. On Nov. 16, 1938, he developed radiation necrosis of the floor of the mouth with a deep slough-lined cavity. Sprays brought very little improvement. On Dec. 16, 1938, ligation of

the left external carotid artery was done. On Jan. 9, 1939, the patient was readmitted to the hospital with a deep cavity in the floor of the mouth filled with slough, the odor of which permeated the entire room. There was also cellulitis of the neck. On Jan. 18, 1939, the cavity was packed with zinc peroxide. The odor was completely gone in 24 hours and much of the slough separated. Clean tissue could be seen in many areas. The lesion was packed once or twice daily with zinc peroxide for eleven days. He was then discharged with the wound completely clean. The cellulitis of the neck disappeared after three days of treatment. The packings were continued intermittently at home by a private nurse and the cavity has remained clean to date. However, on June 21, 1939, the patient suffered a pathologic fracture of the mandible for which sequestrectomy was done on July 3, 1939. This patient was one of the few who complained of a burning sensation of the mouth, due to the zinc peroxide.

Case 7. S. B., 57-year-old, white, married, Russian male. Diagnosis: carcinoma of the tongue. Microscopic diagnosis: squamous carcinoma, Grade II. This patient was first seen on April 14, 1939, with leukoplakia of the tongue and carcinoma involving the dorsal portion. Ligation of both external carotid arteries was done. Gold filtered radon seeds were inserted into a metastatic node in the left carotid bulb region. The patient was given *per oral* roentgen therapy and on May 1, 1939, partial glossectomy was performed. He was treated, 24 hours post-operative, with zinc peroxide. A gauze pad, soaked in the suspension, was placed on the defect, which the patient was able to keep in place for several hours. He was given seven successive daily treatments, with rapid healing and freedom from infection.

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THE ROENTGEN DIAGNOSIS OF CHOLECYSTOCOLIC FISTULA[1]

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IN 1925, Judd and Burden reviewed 153 cases of internal biliary fistulæ. Of this large group, only two were diagnosed pre-operatively by roentgenologic methods. In the last fifteen years roentgenologists have begun to meet this diagnostic challenge, and at the present time there are many reports of internal biliary fistulæ which were diagnosed pre-operatively with the aid of roentgenography.

Internal biliary fistulæ have been reported to involve the gall bladder and almost every other organ in the abdomen and thorax. By far the majority of these fistulæ exist between the gall bladder and the duodenum. In distinction to the abundance of reports concerning the pre-operative diagnosis of cholecyst-duodenal fistula, there is a paucity of reports concerning the pre-operative roentgenologic findings in cholecystocolic fistula. In fact, in this country there have been reports of only five such instances (4, 7, 9, 13, 14).

From the previous reports concerning this type of internal biliary fistula, certain criteria may be selected which are of aid in the diagnosis. These include (1) gas in

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Fig. 1.

Fig. 2.

Fig. 1. Case 1. Flat plate of the gall-bladder region shows the common bile duct and lower biliary ducts to be filled with gas.

Fig. 2. Case 1. Film taken after evacuation of the barium enema shows the location of the fistula and gall bladder in relation to the hepatic flexure of the colon.

the biliary tree, (2) non-visualization of the gall bladder after administration of dye, (3) demonstration by barium enema of the fistulous communication between the colon and gall bladder, and (4) mucous membrane changes in the colon at the site of the fistulous opening.

Gas in the Biliary Tree.—From a theoretic standpoint the presence of gas in the biliary tree is usually assumed to be due to one of three things: (1) Reflux of gas through the ampulla of Vater; (2) the presence of gas-producing organisms in the gall bladder or gall-bladder wall, and (3) existence of an abnormal connection between the digestive system and the bile ducts or gall bladder.

Sickels and Hudson reviewed 10 cases in which there was x-ray evidence of barium in the biliary tree (12). Extension of the barium through the ampulla of Vater was proved in five of these cases. Thus although barium has been observed in the biliary tree without the presence of a fistula, we have been unable to find any instance in which there is proof of reflux gas in the biliary duct system. In this connection we might add that a fistula between the gall bladder and any organ other than the digestive tract does not produce gas in the biliary tree.

Such organisms as *E. coli* and *C. Welchii* have been found in about 50 per cent of surgically removed gall bladders (6), and two cases of gas bacillus infections of the gall bladder have been reported (11). It is important to know that in these patients there is no evidence of gas in the hepatic ducts. Among the somewhat similar lesions, Rigler has mentioned a patient in whom there was emphysema of the gall-bladder walls.

In view of the scarcity of conditions in which there is x-ray evidence of gas in the biliary tree without the presence of an abnormal connection with the digestive system, it is reasonable to assume in the presence of this roentgenologic finding that there is a fistula connecting the biliary system with the digestive system.

Non-visualization of the Gall Bladder.—

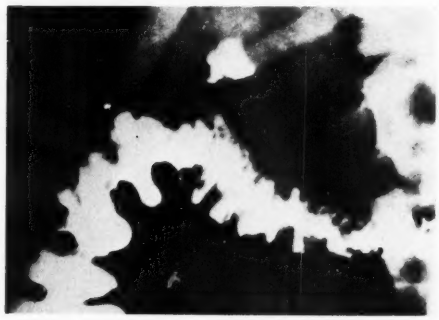

Fig. 3. Case 1. Localized film shows slight alteration of the colon mucosa at the site of the fistulous opening. The gall bladder as visualized by the barium is small and irregular in outline.

In all instances of internal biliary fistula the gall-bladder wall is greatly thickened and contracted and most often there are stones in the lumen. Because of this extensive cholecystitis, the gall bladder is unable to concentrate the radiopaque dye, and hence there is no roentgenographic evidence of the filling of this organ.

In 1885, Murchison found six instances of carcinoma of the gall bladder among nine cases of cholecystocolic fistula (8). This high proportion of carcinoma has not been observed by anyone since that time. Further, there is no instance of carcinoma of the gall bladder in the five cases diagnosed roentgenologically in this country.

Demonstration of the Fistula.—The roentgenographic demonstration of the tract in instances of cholecystocolic fistula is often a difficult procedure. Manipulation of the barium-filled colon in the region of the hepatic flexure may help to fill the fistula. On evacuation films, a small fistulous tract which could not be visualized at the time of the fluoroscopic examination may be seen. Inflation of the colon with air after evacuation of the barium enema may force gas into the gall bladder. Here again manipulation of the colon at the roentgenoscopic examination may be of value in filling the fistula.

Mucous Membrane Changes.—Of the roentgenologic evidences of cholecystocolic fistula, the mucosal pattern changes at the

site of the fistulous opening in the colon are probably of the least significance. This alteration of the mucosal pattern is dependent upon the distortion of the mucosal folds by the inflammatory process associated with formation of the fistula. Inasmuch as there is nothing absolutely specific about this change in the mucosal relief, its presence is of value only when noted with one or more of the other roentgenologic findings mentioned.

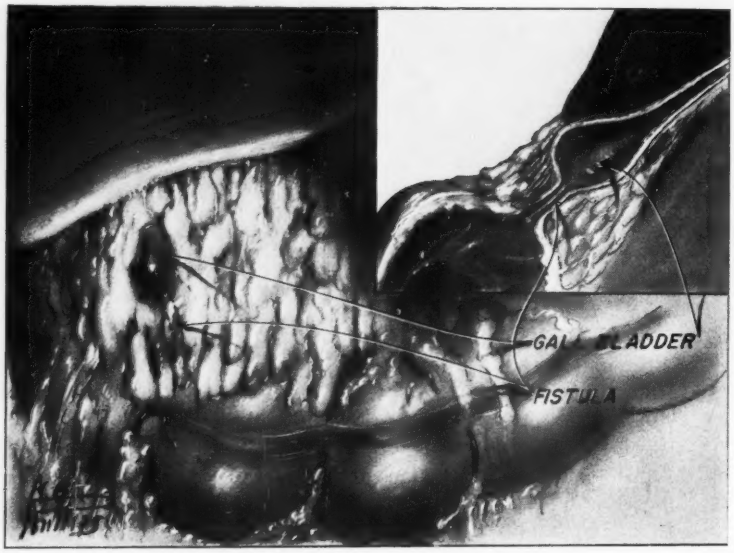

Fig. 4. Case 1. Artist's drawing showing anatomic and pathologic relationships at the time of surgery.

Case 1. This patient was a 57-year-old white male who was first admitted to the Clinic on April 30, 1937. At the time of his admission he stated that five months previously he had had several furuncles in the right groin, which were incised and drained and which healed without further trouble. Soon after this trouble subsided he noted a cramping type of pain in his epigastrium. This pain persisted for the next two months and then suddenly ceased. About six weeks prior to admission he began to have acute attacks of pain in the right upper quadrant of his abdomen. These attacks came on about a week apart and were not accompanied by any other symptoms save that after the last attack there was considerable tenderness over the gall-bladder area.

At the time of admission this patient weighed 168 pounds (76.3 kg.), and there had been no recent change in weight. His past medical history was of no significance. Physical examination did not disclose findings of any importance. No tenderness could be elicited in the abdomen, and no masses could be palpated. Jaundice was not visible. The furuncles in the right groin had healed completely. The Kline test was negative and a complete blood examination, urine analysis, and gastric analysis gave essentially normal findings. Roentgenologic examination of the esophagus, stomach, and duodenum showed no abnormality. After oral administration of iodekon there was no visualization of the gall bladder; however, the common bile duct and lower biliary system were seen to be filled with gas. A diagnosis of non-functioning gall bladder with fistulous communication with a hollow viscus was made.

The next day the colon was examined with a barium enema, and a fistulous tract

was seen to extend from the hepatic flexure up a short distance into a blind pouch which was thought to be the gall bladder. and was dismissed from the hospital on the twenty-first post-operative day. He has been in good health ever since.

Fig. 5.

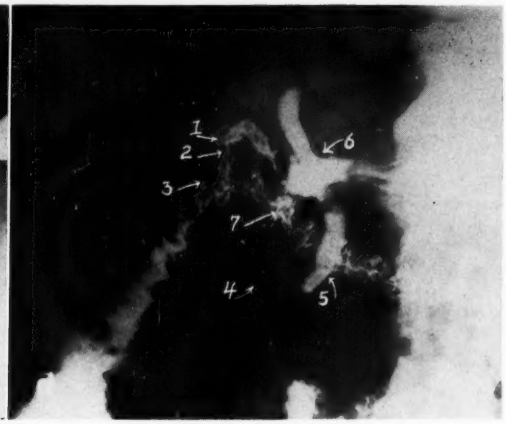

Fig. 6.

Fig. 5. Case 2. Diverticulosis and diverticulitis of the sigmoid.
Fig. 6. Case 2. (1) Gall bladder, (2) fistula, (3) hepatic flexure, (4) descending duodenum, (5) lower end of common bile duct, (6) duodenal cap, (7) duodenocolic fistula.

Double contrast films showed that air was forced from the colon into the gall bladder and biliary tree. Manipulation of the hepatic flexure of the colon was necessary in order that the barium and air might go through the fistula. A diagnosis of cholecystocolic fistula was made.

It was deemed advisable to close the fistulous tract and remove the gall bladder. On opening the abdomen the omentum was found to be adherent to the anterior abdominal wall, liver, and transverse colon near the hepatic flexure. After the adhesions were separated the fistulous tract between the gall bladder and colon was discovered. The gall bladder was atrophied, fibrous, and greatly thickened. The fistulous tract and gall bladder were removed and the opening in the colon closed.

Pathologically the gall bladder showed a subacute and chronic inflammatory process, as did the fistulous tract. The gall bladder contained thin brown bile with a considerable amount of sand-like particles. There was one soft stone, about 0.5 cm. in diameter, in the cystic duct.

The patient made an uneventful recovery

Comment.—It is possible that this patient developed his cholecystitis as a result of a metastatic infection from the furuncles in his right groin. Of probably greater importance, at least from the standpoint of his history, is the fact that his epigastric pain suddenly disappeared. This was almost certainly the time at which the fistulous opening became established and served as a functional outlet for the gall bladder. The acute attacks of pain which occurred at a later date were probably due to movement of the stone in the cystic duct.

Case 2. This patient was a 79-year-old white male who was first seen on Nov. 30, 1926, at which time his chief complaint was pain in the left side of the abdomen. He stated that he had had this pain before and that it had been more severe two days before admission, when it was accompanied by considerable nausea and vomiting, with upper abdominal pain. This pain continued for one day and then suddenly he felt something "give way" and his pain immediately subsided. A diagnosis of diverticulitis of the colon was made, but no roentgen examination was done.

There were many recurrences of the lower abdominal pain during the next 13 years, but it was not until Oct. 18, 1939, hepatic flexure, the duodenal cap and stomach were suddenly filled with barium. The examination was continued and at

Fig. 7.

Fig. 8.

Fig. 7. Case 2. (1) Gall bladder, (2) fistula, (3) hepatic flexure, (4) descending duodenum, (5) small amount of barium in the lower common duct. The plain film of the gall-bladder region shows gas occupying this area. (6) Duodenal cap.

Fig. 8. Case 2. Small vertical gas shadow in common duct. Lack of more filling of the biliary tree makes it impossible to diagnose a cholecystenteric fistula from this film alone.

that a thorough roentgenologic examination was carried out. At that time the patient's chief complaint was pain in the lower abdomen. He gave a history of having two attacks of nausea and vomiting during the past month. Constipation was the only other complaint.

Physical examination showed an elderly, obese, white male. There were no palpable masses in the abdomen, but considerable tenderness was present in the left lower quadrant. The Kline test was negative and a complete blood examination and urine analysis gave essentially normal findings.

Roentgenologic examination of the colon showed an extensive diverticulosis and mild diverticulitis of the sigmoid. As the head of the barium enema neared the the hepatic flexure a fistulous tract was observed to connect with the gall bladder. The gall bladder and common duct were completely filled; the common bile duct was dilated, and no barium entered from the descending duodenum. After an interval of three days a flat plate of the gall-bladder region was made in an effort to demonstrate gas in the biliary tree. This film showed a collection of gas similar in size, shape, and position to a portion of the lower common bile duct. For academic interest a gall-bladder examination was done and no radiopaque dye could be demonstrated.

A diagnosis of duodenocolic and cholecystocolic fistulæ was made. In view of the patient's age, surgical intervention was not considered advisable.

Comment.—The development of these fistulæ seems closely associated with the diverticulitis of the colon. It is possible that diverticula near the hepatic flexure perforated into both the duodenum and gall bladder. However, there is no x-ray evidence of diverticula in this region now. Metastatic infection from the diverticula in the sigmoid to the gall bladder may have given rise to a perforating cholecystitis, but this cannot explain the duodenocolic fistula.

On the basis of the roentgen examination alone, the common bile duct was dilated and appeared obstructed at its distal end. Barium did not flow into the duodenum or regurgitate from the duodenum into the bile duct. This condition is compatible with life in this patient for the bile can flow into the colon *via* the gall bladder.

This patient gave a history similar to the first patient in that there was sudden relief from the pain. It is most likely that one or both of the fistulæ formed at that time.

It is interesting to compare these two patients from a clinical standpoint with those previously reported. The following facts may be found in the five patients previously mentioned: (1) All were women; (2) the average age was 54 years; (3) three had a history suggestive of previous gall-bladder disease, while two had a history of diarrhea over a long period; (4) all were diagnosed by roentgenologic methods and four diagnoses were subsequently proved; (5) there were no instances of carcinoma of the gall bladder or colon in the group.

Summary and Conclusions.—We have reported the clinical and roentgenologic findings in two patients in whom a diagnosis of cholecystocolic fistula was made by roentgenologic methods. One case was proved surgically and the other, due to advanced age, was not.

The roentgenologic diagnosis was made in both instances because of the presence of the following signs: Gas in the biliary tree; non-visualization of the gall bladder after dye administration; demonstration of the fistulous tract after barium enema, and by the changes in the mucosal pattern of the colon at the site of the fistulous opening.

We wish to emphasize: (1) The importance of a history of sudden relief from right upper quadrant abdominal pain and its relationship to internal biliary fistula; (2) the use of plain films of the gall-bladder region in an effort to visualize gas in the biliary tree, and (3) thorough manipulation of the hepatic flexure region when the barium enema is given under roentgenoscopic control.

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FAMILIAL BRACHYPHALANGY[1]

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CAREFUL survey of the literature revealed that every type of anomaly of the extremities has been reported. However, few cases of familial brachyphalangy could be found in the literature.

Köhler in his textbook stated that brachyphalangy may occur in any phalanx. This finding need not necessarily be confined to any one phalanx. Some authors thought that brachyphalangy was only to be found in mongols and idiots. Stettner (7) reported four cases of brachyphalangy who were mongols. However, in his next ten cases out of seven hundred, he could find no trace of mongolism or idiocy. Liebenam (5) reported a case of shortening of the phalanges of both the hands and feet in a family which consisted of a father and six daughters. The foreparents as far as could be determined had normal extremities. Walter (9) cited a case of five generations of short digits but was rather vague as to which phalanges were involved.

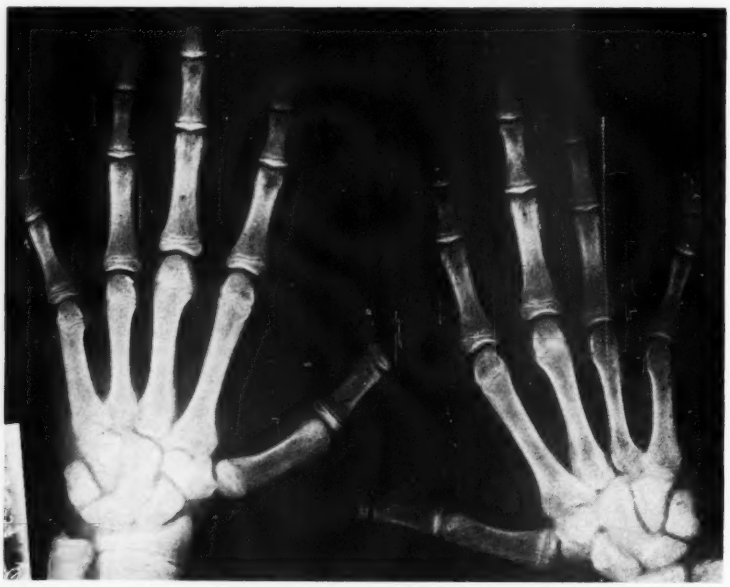

Fig. 1. Roentgenogram of male, fourth generation, 16 years of age. Note the sloping, blunted middle phalanges in the fifth fingers. (Table I-*f*.)

Bouet (1), Funston (2), and Tage-Hausen (8) have also described anomalies of the extremities and their possible etiology, but none aside from Liebenam and Walter have followed these cases to see if the remaining members of the family had the same findings.

Case 1. This case, of an 11-year-old white male, was a rather unusual one in that it involved five generations; the youngest was one year of age and the oldest

[1] Accepted for publication in November, 1939.

80 years of age. In all these cases the brachyphalangy is confined to the mid-phalanx of the fifth finger in both hands.

The patient was hit by a baseball and examination of his hands (Fig. 1) revealed that the fifth fingers of both hands were smaller than the others, extending up to the mid-portion of the middle phalanx of the fourth fingers. They appeared to be swollen, flexed, and curved with the convexity in a medial dorsal direction. The roentgenographs revealed that the middle phalanges of the fifth fingers were shorter and broader than the others. The curvature was due to the abnormal angle of the distal articulating portions of the mid-phalanges. They were not straight and horizontal like the others but slanted in a proximal direction toward the fourth fingers. The epiphyses of all the fingers appeared normal. There was no evidence of a fracture.

A survey of the family for the past five generations revealed a similar finding to that described above (Table I). In some instances we were unable to obtain roentgenographs because the subjects were dead or lived a considerable distance from the radiology department. As a result we were forced to be satisfied with tracings or the word of one of the older relatives. Some of the more sensitive subjects refused to be roentgenographed but we were able to observe the hands. It is worthy of note that the unusual curvature and shortening of the fifth fingers had already caught the eye of the mother of the second generation (Fig. 2-*A*). She made a tracing of her hand (2-*A*), her daughter's (2-*B*, same as Fig. 3-*A*), and half-sister's (2-*C*, from the same mother).

There were no roentgenographs or tracings of members of the first generation but according to the family the mother had the same type of hands. In the second generation there were three males and one female. One male member had a marked curvature of his fifth fingers. Little is known in regard to the other two men.

The female member (Fig. 2-*A*) had a marked deformity of her fifth fingers. In the third generation there were four females, one of them a half-sister by the same mother (Figs. 2-*B*, 2-*C*, and 3), and three males. The roentgenographs and tracings of this group (Figs. 2, 3, and 4) revealed the involvement of the middle fifth phalanges with a resultant shortening and curving of the fifth finger toward the fourth. We were rather fortunate in being able to obtain roentgenographs of the fourth generation (Figs. 1, 5, and 6). The offspring were from both the male and female side. Practically all the members of the families had the same deformity of the fifth fingers. The deformity varied from a minimal crooking of the finger to

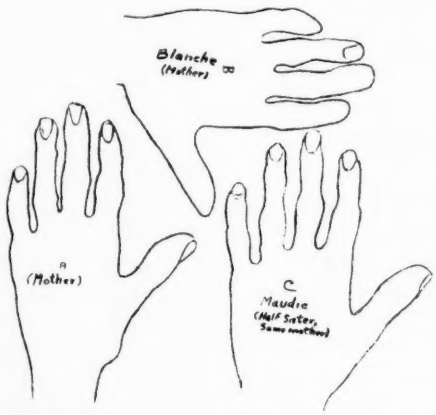

Fig. 2. Tracing of mother of second generation, *A*, and third generation, *B* (same as Fig. 3-*B*), and half-sister, *C*, by the same mother. (Table I-*a*, *b*, *c*.)

Fig. 3-*A*. Photograph of female, aged 51 years, third generation. (Table I-*b*.)

a marked curvature. There were two girls and one boy in the fifth generation and they, too, had the same condition of the fifth fingers, though to a lesser extent. An interesting finding was that the opposite members of the married families did not have this familial brachyphalangy nor did they remember any other members of their families ever having had it. The parents stated that the peculiar curvature

Fig. 3-*B*. Roentgenogram of the same patient.

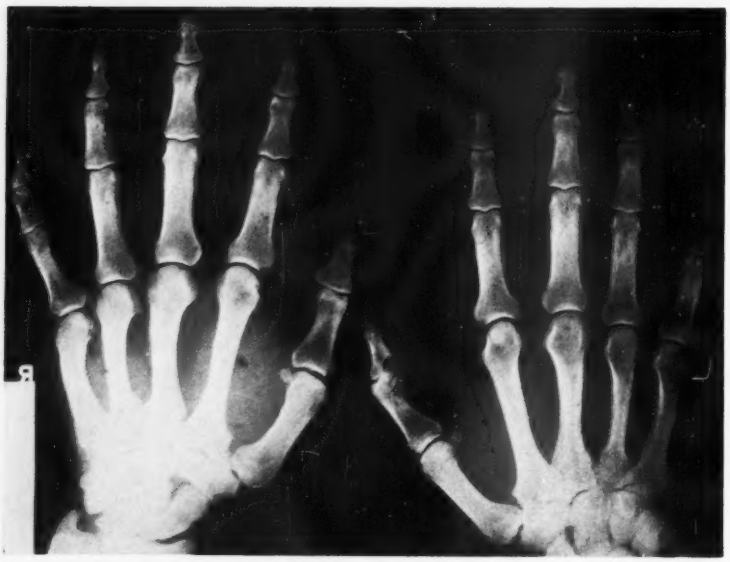

Fig. 4. Male member of the third generation, 47 years of age. (Table I-*d*.)

of the fifth fingers was noted at birth. X-rays of the feet and sella turcica were within normal limits.

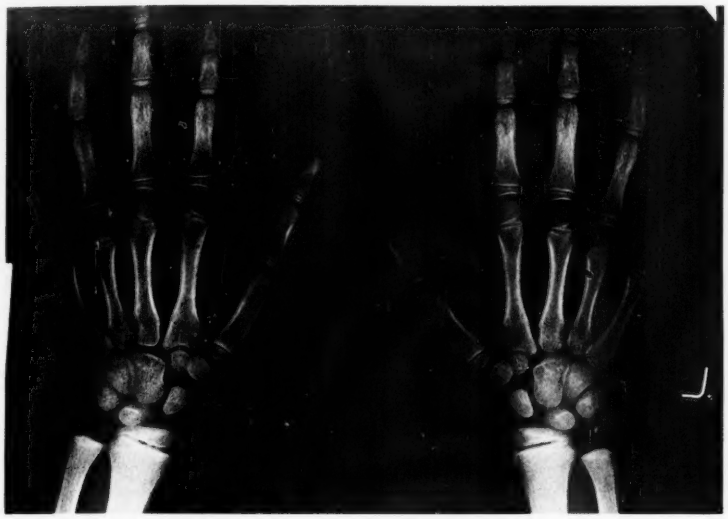

Fig. 5. Roentgenogram of female, aged seven, male offspring. (Table I-g.)

ETIOLOGY

Many theories have been offered as possible explanations for the many anomalies that one sees in the extremities. They may be briefly summarized as follows:

1. Heredity causes anomalies. This theory is sponsored by Gaenslen, Volkman, and MacKenzie (4).

2. Absence of embryonal anlage produces defects in the skeleton.

3. Gaenslen also adds the additional theory that bone defects may be due to pressure from amniotic bands, adhesions between the amnion and fetus, or to a small amnion which will cause pressure on the developing fetus. This theory is supported by Dareste and St. Hilaire, Handeck, and Krebster. The optimum time for the occurrence of these adhesions is between the fifth and eighth week. Later, due to the increase in amniotic fluid, the adhesions may break. Many amniotic tags may be seen in deliveries.

4. Jansen, according to Lewin (4), says that it is quite possible for an increase in amniotic pressure to disturb the normal nutrition and the growth of the embryo in that particular location while the non-affected part will continue to grow in a normal manner.

5. Alcohol and syphilis are mentioned as possibilities.

SUMMARY

1. Five generations of brachyphalangy involving the mid-phalanx of the fifth fingers have been described and illustrated.

2. Thirty-two members of the family have been investigated; 15 females and 17 males.

3. All 32 had some degree of the peculiar curving of the fifth fingers which apparently was caused by the shortened, broadened, and sloping middle phalanx.

4. This anomaly was equally transmitted by both males and females.

5. There was no instance of mongolism or idiocy.

6. Roentgenograms of the feet and sella turcica were normal.

CONCLUSIONS

After analyzing all the possible etiologic

Fig. 6. Female member of the fourth generation, 29 years of age. (Table I-*e*.)

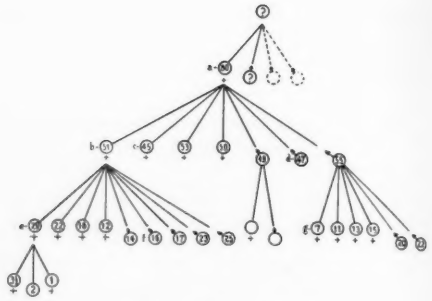

TABLE I.—GENEALOGY

Note.—Numbers = age. *a*, *b*, *c* = Fig. 2; *b* = Fig. 3; *d* = Fig. 4; *e* = Fig. 6; *f* = Fig. 1; *g* = Fig. 5. Dotted lines = no trace.

factors as to the origin of this brachyphalangy, we must confess that we are still at a loss. However, one cannot accept amniotic bands and tags as the cause of the above instances. We must remember that many amniotic tags are seen during normal deliveries. It would appear to be a remarkable coincidence if the amniotic bands were to affect only the mid-phalanges of the fifth finger in five successive generations. For the same reason as that just given we should discard the anlage theory. Therefore, until one can offer a better explanation, we are forced to conclude that the brachyphalangy is due to heredity and is a familial characteristic.

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MEDICINE AND THE PRESS

The subjects of "public relations" and "publicity" have, within recent years, been mentioned with increasing frequency when groups of physicians have gotten together for a discussion of their profession and the social and economic problems confronting it.

The fact is that doctors of medicine have only recently begun to give thought to their relations with the public. It is perhaps understandable, therefore, that the average doctor approaches the subject with less than an expert knowledge of the meaning and the technic of "public relations." The concept of public relations is foreign, indeed it is nonexistent, in the training for and practice of a profession which deals solely with the individual organism. The patient is invariably studied and treated as a distinct individual; but public relations follow an opposite process. The individual is merged into the group and the social organism is studied as a whole. One of the academic postulates in psychologic sociology is that the whole is greater than the sum of its parts. Examples are legion to show that the public mind is often a radically different thing than a summation of the opinions of the individuals who make up the group.

This latter phenomenon is one which the doctor may readily observe in his own relations with the public. Rarely does he find one of his patients expressing anything but respect, confidence, and admiration for his physician. It is somewhat paradoxical to observe, however, that the public, which is made up of these very same patients, manifests something akin to hostility toward the medical profession.

Of course, medicine is not the only group interest that has been tardy in recognizing the tremendous importance of that shifting, plastic thing called "the public mind." Business has long recognized the value of advertising and publicity; only lately has it grasped the concept of public relations. Within the last year the National Association of Manufacturers has begun an institutional campaign and created a national information bureau as a part of a sustained public relations program directed toward winning the confidence and esteem of the public for the manufacturer.

During the last decade, the concept of public relations has suddenly struck home in the hearts of the whole generation, and as the magazine, *Fortune*, has said, "The vast, ephemeral, ponderous though liquid, thing called the public mind has forced itself upon the consciousness of men."

Doctors, as a whole, have begun to appreciate the importance of public relations and to realize that the profession of medicine, itself a minority group, is dependent upon the public mind for the support of its principles. Dr. Howard W. Haggard, of Yale University, one doctor who, incidentally, has manifested an erudite understanding of public relations, says, "I am convinced that it is utterly futile for the doctor to struggle against the current of public opinion. His one hope lies in changing the direction of the current. And the only way the direction of the current can be changed is through propaganda in the interest of the medical profession."

Contrary to what many persons think, publicity is not public relations. Publicity calls attention to a person, a product, a service, or an idea. Publicity has been obtained, or has resulted, when a sensational newspaper spreads the name of some doctor all over the front page in connection with a garbled story of questionable scientific veracity.

Press agentry is not public relations. Press agentry creates circumstances which get reported in the news. In the case of the medical profession, there is no need to create circumstances, because they occur with spontaneous frequency. The question is how they should be handled after they occur.

Advertising is not public relations. Advertising creates desire for, or acceptance of, a person, product, service, or an idea through the use of paid space or radio time. All three—publicity, press agentry, and advertising—are utilized in the technic of public relations.

These various technics can be applied to any one of several media. The daily newspaper, the radio, the speaker's platform, the motion picture, and other media are customarily employed in any effort to influence the opinion of the public. By far the most important, however, is the daily press. The vast majority of

persons in this mighty land acquire the bulk of their knowledge and unconsciously form nearly all of their opinions from their daily newspaper. It is the daily newspaper, therefore, which medicine must resort to if it wants to mould the public mind.

This desire to mould the public mind, incidentally, is devoid of any ulterior motive. Everything done to foster the cause of medicine invariably reacts to the ultimate benefit of the public. Those principles to which organized medicine subscribes and which are attacked in propaganda campaigns by certain minority groups were promulgated for the benefit of the public.

This is a fact difficult of comprehension to the average newspaperman. While other organized groups were resorting to all kinds of sly tricks in an effort to obtain publicity, it has struck the newspaperman as imponderable that the medical profession was not only making no effort to obtain publicity, but was actually obstructing his efforts to obtain facts regarding medical events which he considered as having a public interest.

This curious phenomenon was the subject of comment in a recent article by Raymond Clapper, Washington correspondent for the Scripps-Howard newspapers. He describes the enthusiastic co-operation extended by the President and other administrative heads to the press. He remarks that politicians as well as industry have found that they cannot ignore the public but must actively court its favor. "The medical profession has been negligent in this regard," he concludes.

That is putting it mildly. As a matter of fact, doctors have acquired a notorious reputation among newspapermen for manifesting an inept attitude in their relations with the press. Every reporter has his tales about difficulties encountered in running down the facts of the illness of some prominent person or in covering an important medical meeting.

Newsmen, on the other hand, are traditionally looked upon with disdain by members of the medical profession because of the familiar and frequently well founded charge that medical news in the daily press is scientifically inaccurate and factually garbled. Every doctor has witnessed the phenomenon of "parrot journalism." An enterprising newsman picks up a story about an illness or an operation on some local citizen and, just to make it good, he describes it as a "rare malady" or a "delicate operation." This inspires a similar story in some other locality, thus starting a chain of sensational dispatches, culminating in a veritable epidemic, and proving, in the end, that the condition was not "rare" at all.

Unwarranted sensationalism and carelessness in interpretation of scientific events have likewise contributed to the disrespect of the average doctor for medical news reporting. Some essayist at a medical meeting makes the cautious statement that a superabundance of vitamin E in the diet may, in the light of future experiment, lead to the indication that it is a predisposing factor in some forms of carcinoma. Another physician on the same program might refer to the presence of vitamin E in spinach. Thereupon the astonished doctors awake next morning to find their morning newspaper screaming the headline, "Spinach Causes Cancer, Learned Doctor Declares."

Let it be clearly understood that the fault is not entirely one-sided. Sensational distortions of true scientific facts which so frequently appear in the daily press are not solely chargeable to shoddy journalistic practices by newspapermen; some of the fault lies with the medical profession in failing to co-operate with the press by providing it with authentic material. A newspaper reporter has no deliberate desire to publish a story which is scientifically inaccurate. He frequently does so because it is so very difficult for him to run down the true facts. He is amazed at the typical reticence of the average doctor and sometimes reaches the logical conclusion that medicine desires to hide itself behind a cloak of secrecy and esoteric mystery.

A definite and sustained program in press relations for radiology has been a subject of study by the Inter-Society Committee for Radiology and the Commission on Public Relations of the American College of Radiology. Sufficient funds are not avilable to permit an ambitious or a very extensive program. As indicated in the beginning of this discussion, however, a great deal can be accomplished toward the obtaining of favorable news by doing nothing more than co-operating with, and offering assistance to, the representatives of the press. The Commission on Public Relations proposes to provide this co-operation and assistance. The executive secretary of the College has had considerable experience in journalism and his services can be utilized in carrying out such a program.

One of the essential requisites of a news story is its timeliness. It cannot begin with a "lead" stating that "last week," or "several days ago" something happened. If it does not begin with "to-day" or "yesterday," it is a feature story of the magazine type. Two opportunities are presented for news stories pertaining to radiology which provide a timely element; the publication of scientific papers in the national journals and the annual sessions of the societies. It is hoped that a program will eventually be established to take advantage of all these opportunities.

At present, the Commission on Public Relations has proposed a definite program of press relations for the annual sessions of the scientific societies, and has offered its services to these societies in executing the program. The Radiological Society of North America has accepted this offer and the Commission will assist that Society's Committee on Publicity during the forthcoming meeting at Cleveland.

In brief outline, the project will be carried out as follows:

1. The advance program of the Annual Meeting, containing abstracts of papers, will be studied and those offering news possibilities will be selected. To be so selected, a paper must offer two requisites: It must contain material of news interest to the public and offer a vehicle for favorable propaganda. The word "propaganda" is here used in its enlightened sense—educational material creating a favorable understanding of the profession of radiology and its practitioners. It should be emphasized here that a paper of outstanding scientific significance may very well offer no possibilities for publicity. It may be too technical, or it may concern a subject that cannot be adequately or safely presented in a news story for the public.
2. The manuscripts of the papers selected will be requested from the essayists and the Commission's secretary will prepare a news story thereform. These stories will be submitted to the chairman of the Commission for careful check-up to avoid any scientific inaccuracy.
3. Mimeographed copies of these stories will be prepared for release *after* the papers have been presented at the Meeting. Several will be released each day at scheduled press conferences for morning and evening papers and the wire services.
4. Reporters assigned to the Meeting will be met by the Commission before the session opens and press headquarters will be maintained throughout the Meeting, where its members will be available to answer questions and interpret papers for newsmen. The Commission will employ a photographer to provide the newspapers with photographs.

The Commission on Public Relations will undertake this new program with circumspection. It has no desire to undertake a radical or too ambitious program in the beginning. Its chief aim during the early stages of the program will be, not to create or encourage news stories, but to avoid the publication of inaccurate or unethical stories. This can be accomplished merely by co-operating with the press and providing it with news stories of the proper type.

One principle the Commission will follow diligently. It will make every effort to discourage the publication of news that has as its principal effect the aggrandizement of an individual. Rather, it will endeavor to utilize every news story as a means of educating the public toward a respectful understanding of the science of radiology. Its aim will be to achieve recognition of the fact that a radiologist is a clinical consultant and that his profession has contributed generously to the progress of medicine and the welfare of humanity.

MAC F. CAHAL,
Executive Secretary.

RADIOLOGICAL SOCIETIES IN NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

UNITED STATES

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles; *Secretary,* Carl D. Benninghoven, M.D., 95 S. El Camino Real, San Mateo.

Los Angeles County Medical Association, Radiological Section.—President, M. L. Pindell, M.D.; *Vice-president,* Richard T. Taylor, M.D.; *Secretary,* Wilbur Bailey, M.D., 2007 Wilshire Blvd.; *Treasurer,* Henry Snure, M.D., 1414 South Hope Street; Kenneth Davis, M.D., *Member of Executive Committee.* Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Chairman, William E. Costolow, M.D., Los Angeles; *Members of Executive Committee,* I. S. Ingber, M.D., San Francisco; D. R. MacColl, M.D., Los Angeles, and J. D. Coate, M.D., Oakland; *Secretary-Treasurer,* L. Henry Garland, M.D., 450 Sutter St., San Francisco. Executive Committee meets quarterly; Society meets annually during annual meeting of the California Medical Association.

San Francisco Radiological Society.—Secretary, Harold A. Hill, M.D., 450 Sutter Street. Meets monthly on third Thursday at 7:45 P.M., for the first six months at Toland Hall (Univ. of Calif. Med. School) and for the second six months at Lane Hall (Stanford Univ. School of Med.).

COLORADO

Denver Radiological Club.—President, N. B. Newcomer, M.D., 306 Republic Bldg.; *Vice-president,* Elizabeth Newcomer, M.D.; *Secretary,* Paul R. Weeks, M.D., 520 Republic Bldg.; *Treasurer,* L. G. Crosby, M.D., 366 Metropolitan Bldg. Meets third Friday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Chairman, Owen J. Groark, M.D., 881 Lafayette St., Bridgeport; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida Radiological Society.—President, J. H. Lucinian, M.D.; *Vice-president,* John N. Moore, M.D.; *Secretary-Treasurer,* Elliott M. Hendricks, M.D., 314 Sweet Bldg., Fort Lauderdale. The next meeting will be at the time of the annual meeting of the Medical Association of Florida in the spring.

GEORGIA

Georgia Radiological Society.—President, Robert Drane, M.D., DeRenne Apts., Savannah; *Vice-president,* J. J. Collins, M.D., Archbold Hospital, Thomasville; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic Bldg., Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—President, Adolph Hartung, M.D.; *Vice-president,* Warren W. Furey, M.D.; *Secretary,* Chester J. Challenger, M.D., 3117 Logan Blvd. The Society meets at the Palmer House on the second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—President, Harry W. Ackeman, M.D., 321 W. State St., Rockford; *Vice-president,* D. R. Hanley, M.D., St. Mary's Hospital, Streator; *Secretary-Treasurer,* William DeHollander, M.D., St. John's Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Chairman, Warren W. Furey, M.D., 6844 Oglesby Ave., Chicago; *Secretary,* Harry W. Ackeman, M.D., 321 W. State St., Rockford.

INDIANA

The Indiana Roentgen Society.—President, H. H. Inlow, M.D., Shelbyville; *President-elect,* Charles Wyeth, M.D., Terre Haute; *Vice-president,* C. A. Stayton, M.D., Indianapolis; *Secretary-Treasurer,* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—President, D. B. Harding, M.D., Lexington; *Vice-president,* I. T. Fugate, M.D., Louisville; *Secretary-Treasurer,* Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Chairman, John W. Pierson, M.D., 1107 St. Paul St.; *Secretary,* Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

The Thirty-first Annual Midwinter Conference of Eastern Radiologists will meet in Baltimore on Jan. 31 and Feb. 1, 1941.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—President, O. J. Shore, M.D., 552 Fisher Bldg., Detroit; *Vice-president,* Clarence E. Hufford, M.D., 421 Michigan St., Toledo, Ohio; *Secretary-Treasurer,* E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—President, J. H. Dempster, M.D., Detroit; *Vice-president,* L. E. Holly, M.D., Muskegon; *Secretary-Treasurer,* J. E. Lofstrom, M.D., 1536 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—President, Harry Weber, M.D., Mayo Clinic, Rochester; *Vice-president,* G. T. Nordin, M.D., Minneapolis; *Secretary,* John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—President, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Kansas; *Secretary,* Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—President, Oscar C. Zink, M.D., St. Luke's Hospital; *Secretary,* Wilbur K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—President, Roy W. Fouts, M.D., 1007 Medical Arts Bldg., Omaha; *Secretary,* D. Arnold Dowell, M.D., 816 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *Secretary,* Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, James G. Boyes, M.D., 912 Prospect Ave., Plainfield; *Vice-president,* Nathan J. Furst, M.D., 190 Johnson Ave., Newark; *Secretary,* W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer,* H. A. Vogel, M.D., 1060 East Jersey St., Elizabeth, and *Counsellor,* H. J. Perlberg, M.D., 921 Bergen Ave., Jersey City. Meetings at Atlantic City at time of State Medical Society and Midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—President, I. J. Landsman, M.D., 910 Grand Concourse, New York City; *President-elect,* D. E. Ehrlich, M.D., 35 West 92nd St., New York City; *Vice-president,* Frederic E. Elliott, M.D., 122 76th St., Brooklyn; *Treasurer,* Solomon Fineman, M.D., 133 East 58th St., New York City; *Secretary,* William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—President, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts.; *Secretary-Treasurer,* L. J. Taormina, M.D., 1093 Gates Ave. Meetings held the fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—President, Edward Koenig, M.D., 100 High St., Buffalo; *Vice-president,* W. Roger Scott, M.D., 598 Pine St., Niagara Falls; *Secretary-Treasurer,* Joseph S. Gian-Franceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—President, Albert Lenz, M.D., 613 State St., Schenectady; *Vice-president,* Dwight V. Needham, M.D., 123 Sedgwick St., Syracuse; *Secretary-Treasurer,* Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—President, Samuel G. Schenck, M.D., Brooklyn; *Vice-president,* G. Henry Koiransky, M.D., Long Island City; *Secretary,* Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer,* Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, Henry K. Taylor, M.D., 667 Madison Ave., New York City;

Vice-president, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains, N. Y.; *Secretary*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City, and *Treasurer*, Paul C. Swenson, M.D., 168th St. and Broadway, New York City.

Rochester Roentgen-ray Society.—Chairman, George H. S. Ramsey, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Ohio Radiological Society.—President, U. V. Portmann, M.D., Cleveland; *Secretary*, J. E. McCarthy, M.D., Cincinnati. A committee was appointed to draw up a constitution and by-laws. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—President, L. A. Pomeroy, M.D., Hanna Bldg., Cleveland; *Vice-president*, P. C. Langan, M.D., 215 Wellesley Ave., Akron; *Secretary-Treasurer*, H. A. Mahrer, M.D., 10515 Carnegie Ave., Cleveland. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President*, Samuel Brown, M.D.; *Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, H. Norton Mawhinney, M.D., Pittsburgh; *President-elect*, Peter B. Mulligan, M.D., Ashland; *First Vice-president*, Harold S. Callen, M.D., Bradford; *Second Vice-president*, Harold W. Jacox, M.D., Pittsburgh; *Secretary-Treasurer*, L. E. Wurster, M.D., 416 Pine St., Williamsport; *Editor*, William E. Reiley, M.D., Clearfield; *Assistant Editor*, Sydney J. Hawley, M.D., Danville; *Censor for Three Years*, A. R. Snedden, M.D., McKeesport. The Society meets annually; time and place of next meeting will be announced later.

The Philadelphia Roentgen Ray Society.—President, Jacob H. Vastine, II, M.D., Medical Arts Bldg., Philadelphia; *Vice-president*, A. Maxwell Sharpe, M.D., 708 Sproul St., Chester; *Secretary*, Barton R. Young, M.D., Temple University Hospital, Philadelphia; *Treasurer*, Fay K. Alexander, M.D., Chestnut Hill Hospital, Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—President, Paul G. Bovard, M.D., 306 Corbett St., Tarentum, Pa.; *Vice-president*, John H. Gemmell, M.D., 262 Connecticut Ave., Rochester, Pa., and *Secretary-Treasurer*, Harold W. Jacox, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings held second Wednesday of each month at 4:30 P.M., from October to June, at various hospitals designated by program committee.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, T. A. Pitts, M.D., Columbia; *Secretary-Treasurer*, Malcolm Mosteller, M.D., Columbia Hospital, Columbia. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—President, Eugene Abercrombie, M.D., 305 Medical Arts Bldg., Knoxville; *Vice-president*, Christopher C. McClure, M.D., 404 Doctors Bldg., Nashville; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, C. F. Crain, M.D., Corpus Christi; *President-elect*, M. H. Glover, M.D., Wichita Falls; *First Vice-president*, G. D. Carlson, M.D., Dallas; *Second Vice-president*, P. E. Wigby, M.D., Dallas; *Secretary-Treasurer*, L. W. Baird, M.D., Scott and White Hospital, Temple. Meets annually. The next annual meeting is to be Jan. 18, 1941, in Sherman.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Virginia Radiological Society.—President, Wright Clarkson, M.D., Petersburg; *Vice-president*, Clayton

W. Ely, M.D., Norfolk; *Secretary*, Charles H. Peterson, M.D., 603 Medical Arts Bldg., Roanoke.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Vice-president*, George Cornett, M.D., Yakima; *Secretary-Treasurer*, Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—President, H. W. Hefke, M.D.; *Vice-president*, Frederick C. Christensen, M.D.; *Secretary-Treasurer*, Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301 Service Memorial Institute.

CANADA

Section on Radiology, Canadian Medical Association.—Chairman, Gordon Richards, M.D., Medical Arts Bldg., Toronto; *Secretary*, W. J. Cryderman, M.D., Medical Arts Bldg., Toronto.

Section on Radiology, Ontario Medical Association.—Chairman, E. H. Shannon, M.D., St. Michael's Hospital, Toronto; *Secretary*, W. J. Cryderman, M.D., 474 Glenlake Avenue, Toronto.

Canadian Association of Radiologists.—President, J. E. Gendreau, M.D., Montreal; *Vice-president*, W. H. McGuffin, M.D., Calgary; *Honorary Secretary-Treasurer*, W. L. Ritchie M.D., Montreal; *Chairman of Interrelations Committee*, G. E. Richards, M.D., Toronto.

La Société Canadienne-Française d'Electrologie et de Radiologie Médicales held a meeting at Quebec on Sept. 28, 1940, at which time the following officers were elected for the next two years: *President*, Albert Comtois, M.D., Hôpital Ste.-Justine, Montreal; *First Vice-president*, Jules Gosselin, M.D., Hôpital St.-Sacrement, Quebec; *Second Vice-president*, Paul Brodeur, M.D., General Hospital, Ottawa; *General Secretary*, Origène Dufresne, M.D., Institut du Radium, Montreal, and *General Treasurer*, Doriva Léonard, M.D., Hôpital Notre Dame, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

MILITARY RADIOLOGY

A great opportunity and a duty confront American radiologists at this time when a tremendous change menaces the political and economic face of the earth. At last the United States has awakened to the need of preparing for national defense, and as a specialist group whose services will be required in a large and definite way, it is our privilege to foresee, aided by the experience of the last great war, the widening field of military roentgenology, both in preparation for defense and in view of possible need for offensive warfare. The problems are alike.

The radiological specialists of this country can look back with some pride on their participation in the World War years of 1917 and 1918. Before that time the regular Army medical department had foreseen the need of special equipment for field service and in 1914 had begun to expand the already existing Army x-ray service (similar in most respects to that of civil hospitals) to include training of a few radiologists, several of whom have become well known and front-rank members of our national radiological societies.

However, with the entrance of the United States into the war in 1917, it was at once apparent that both the Army and Navy were starting practically from scratch in the enormous task of providing equipment and personnel for the radiological service of a nation at war. How well this was done is a matter of history. Under the wise and able guidance of Colonel Arthur C. Christie who had already established an excellent standing as a radiologist while serving as an officer in the regular Army, the Surgeon-General promptly set up a Division of Roentgenology in the Army medical organization, which made a survey of manufacturing facilities for the equipment of a vast radiological service: existing hospitals of the regular Army posts, Army training camp hospitals, and Red Cross hospitals. Various types of equipment were supplied—base hospital stationary types and transportable types. Further aid by Dr. Coolidge and Prof. J. S. Shearer resulted in the development of a highly efficient portable apparatus, self-rectifying, deriving its power from an air-cooled gasoline engine modified to produce alternating current. Adaptation of this instrument to a motor ambulance rendered it easy to assemble a complete radiological equipment in a single conveyance. A further development was the U. S. Army x-ray table with a removable top interchangeable with a stretcher. It seems that little change would be needed in these instruments to-day to make them perfectly suitable for modern military roentgenology.

The localization methods in use twenty-three years ago have changed only in the direction of simplicity. The triangulation method of Strohl, the parallax method, and the nearest point method all proved to be useful, reliable, and rapid, all capable of use with the fluoroscope without the necessity of films. Recent publications in German and in French would indicate no essential change in the methods advocated above. There are perhaps two hundred other methods, all classifiable under a half-dozen types, but the simpler, purely screen methods are best. When mechanical aids which can be utilized in the operating room are needed as a means of localizing during extraction of foreign bodies, several compass methods are available.

Fluoroscopic aid during the actual extraction of foreign bodies is desirable in many cases. At the entry of the United States into the last great war, few of our surgeons or radiologists were appreciative of the great help offered by fluoroscopy in the operating room. Special instruction was given, the methods being patterned after those employed by the French, especially the use of the Dessane bonnet in the usual light of the operating room with a portable x-ray equipment and a tube under the stretcher used as the operating

table. It is the writer's observation that few surgeons to-day are familiar with the proper and safe use of the fluoroscope in the removal of foreign bodies or in the control of fractures. This instruction will have to be developed again.

The newer phases of military roentgenology involve a great increase of fractures and other injuries from motor cars and airplanes and especially from motorcycles. This has been true in Europe, where blackouts have added greatly to the risk of motor transportation.

A further new opportunity for x-ray aid in military medicine has to do with the enlistment examinations of recruits, all of whom should have permanent x-ray records of the chest before entering service, as well as on discharge. Such records will save untold sums in forestalling unjust post-emergency claims for disability. It may be possible to develop further mass x-ray examinations now that photography of the fluorescent screen has been made a reality. The perfection in instruments achieved in recent years has opened doors to betterment of diagnostic methods and greatly broadened the field in which the radiologist and his technical assistants must be proficient.

The real problem now will become the training of the greatly augmented military medical personnel for the expanding regular and national Army and for building up adequate reserves. In 1917–1918 it was accomplished by the Radiological Committee of Preparedness, co-operating with the Surgeon-General's office, who established schools for the instruction of radiologists in nine of the larger cities throughout the country, manned by faculties provided by the various communities in which the schools were located. Later these schools were consolidated into centers at New York City, Fort Oglethorpe, and Fort Riley. Still later the instruction at the New York School of Military Radiology and at Fort Riley were transferred to Camp Greenleaf at Fort Oglethorpe, where the training of radiologists was centered. The course of instruction lasted two months, the more advanced clinical instruction being curtailed and the principal attention being given to localization of foreign bodies, care and operation of the apparatus, practical fluoroscopic and radiographic work.

In addition to the training of medical officers, the school also gave a course of training to enlisted men and these were called "manipulators." These men were also trained in trouble-hunting and repair of the apparatus, care, handling and filing of material, and in the use of the portable or bedside equipment.

There will probably be calls in the near future for a number of physicians for military radiology which will perhaps more than equal the present number of Diplomates of the American Board of Radiology. Should the emergency demand rapid preparation of some hundreds of radiologists for such military service, great care will be needed in their instruction. It will not be possible to anywhere near approximate the standards set up by the American Board of Radiology. In the World War—1914–1918—physician-radiologists were prepared in two or three months and manipulators in one month, but this was because of the urgent call for their services. More should be done now to prepare men for x-ray service.

The radiologists of America stand ready to do their full duty. We need not neglect our experience of two decades ago. Observers of previous war experience are being sent to the war zone to bring back first-hand, up-to-the-minute military information. It would seem important that a medical team also be sent to make observations, and one member of such a team should be a radiologist. Such reports would be invaluable in the preparation of new and revised texts for use in the instruction and guidance of students and newly trained officers. The need of this instruction will undoubtedly have been foreseen by the Army and Navy Medical Departments, and it may be that plans are already complete. Ours is the duty and privilege of co-operating to the fullest of our ability.

JAMES T. CASE, M.D.
Senior Consultant in Surgery (Roentgenology), A.E.F.

THE NEXT ANNUAL MEETING

THIRD ANNUAL REFRESHER SERIES

Complete information concerning the Third Annual Refresher Series to be presented at Cleveland, Dec. 1–6, 1940, at the time of the Annual meeting, will be found in the September issue of RADIOLOGY. Also included in that issue is an enrollment blank for the Series. The courses will not conflict in any way with the parent meeting.

Admission to the courses is without fee but will be by card only. Enrollment will be limited and will be determined by the comfortable seating capacity of the rooms available at the hotel.

Upon receipt of application, cards confirming the enrollment will be mailed, and tickets entitling the enrollee to admission to the courses will be available at the time of registration for the Annual Meeting at the Hotel Statler, Cleveland, Ohio.

SCIENTIFIC PROGRAM FOR THE TWENTY-SIXTH ANNUAL MEETING OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

HOTEL STATLER, CLEVELAND, OHIO, DEC. 2, 3, 4, 5, AND 6, 1940

MONDAY

10:30 A.M.

CALL TO ORDER . . . BERNARD H. NICHOLS, M.D. President of the Radiological Society of North America

Address of Welcome . . CHARLES T. WAY, M.D. President of the Academy of Medicine, Cleveland

Scientific Sections

1. Observations Gleaned from Clinical and Radiological Chest Examinations of Recruits. W. H. MCGUFFIN, M.D., Calgary, Alberta, Canada
2. Reminiscences of Roentgenology during the Last World War and Review of Some of the 17,000 Examinations. EDWIN C. ERNST, M.D., St. Louis, Mo.
3. Medical Preparedness, with Special Reference to Radiology. Captain LUTHER SHELDON, JR., Medical Corps, U. S. Navy, Washington, D. C.
4. U. S. Public Health Service. JOHN E. WIRTH, M.D., Baltimore, Md.

4*a*. Wartime Military Roentgenology. A. A. DE LORIMIER, Major, Medical Corps, U. S. Army, Washington, D. C.

All of the foregoing to be discussed by A. C. CHRISTIE, M.D., Washington, D. C., and JAMES T. CASE, M.D., Chicago

Monday Afternoon, 2:00 P.M.

Diagnostic, Chairman, BERNARD H. NICHOLS, M.D.

5. Excretory Urography for Children. GEORGE M. WYATT, M.D., Boston
6. Pyelography in the Upright Position. J. ANDREW BOWEN, M.D., Louisville, Ky.

The two foregoing to be discussed by E. C. BAKER, M.D., Youngstown, Ohio

7. Pancreatic Tumors, A Roentgenological Study. SAMUEL BROWN, M.D., Cincinnati, Ohio

To be discussed by HARRY HAUSER, M.D., Cleveland, Ohio

8. Mediastinal and Pulmonary Changes in Erythema Nodosum. ERNST A. POHLE, M.D., Ph.D., Madison, Wis.
9. The Features of Mediastinal, Pulmonary, and Pleural Involvement in Lymphomatoid Processes. LLOYD F. CRAVER, M.D., and JOHN O. VIETA, M.D., New York City.

The two foregoing to be discussed by L. R. SANTE, M.D., St. Louis, Mo., and HOWARD P. DOUB, M.D., Detroit, Mich.

10. Alkaptonuria, Ochronosis, and Arthritis. MAURICE M. POMERANZ, M.D., New York City

To be discussed by W. J. ZEITER, M.D., Cleveland, Ohio

Monday Afternoon, 2:00 P.M.

Therapeutic, Chairman, ROBERT R. NEWELL, M.D., San Francisco, Calif.

11. Criteria for the Diagnosis of Malignancy. ALLEN GRAHAM, M.D., Cleveland, Ohio (This paper will not be formally discussed but questions may be asked.)
12. Roentgen Therapy in Cancer of the Breast Used Pre-operatively or in Cases Not Operated upon. MAURICE LENZ, M.D., New York City

To be discussed by U. V. PORTMANN, M.D., Cleveland, Ohio

13. Late Results in Benign Giant-cell Tumors of Bone. T. LEUCUTIA, M.D., and E. R. WITWER, M.D., Detroit, Mich.

To be discussed by JOHN T. MURPHY, M.D., Toledo, Ohio, and JAMES A. DICKSON, M.D., Cleveland, Ohio

14. Roentgen Irradiation on Chronic Lymphatic Leukemia. W. C. POPP, M.D., and C. H. WATKINS, M.D., Rochester, Minn.

To be discussed by ARTHUR W. ERSKINE, M.D., Cedar Rapids, Iowa

15. Studies on the Concentration of Organic Dyes in Tumor Tissue. PAUL A. ZAHL, Ph.D., New York City
16. The Metabolism of Radio-phosphorus by Malignant Neoplasms in Human Beings. J. M. KENNEY, M.D., and L. D. MARINELLI, M.A., New York City

The two foregoing to be discussed by PAUL S. HENSHAW, Ph.D., Bethesda, Md.

Tuesday Morning—*General*

Tumor Clinic

A Tumor Clinic in Action, L. A. POMEROY, M.D., and S. C. FREEDLANDER, M.D., Directors; J. H. LAZZARD, M.D., Executive Secretary. The regular Tuesday morning Tumor Clinic of Cleveland City Hospital will be held at the Hotel Statler. Patients, physicians, nurses, secretary, social worker, x-ray viewing box, and microscopic slide projector will be moved *en masse*.

There will be presentation of patients, discussion, and recommendation of treatment for each case.

Tuesday Afternoon

Executive Session, 2:00 P.M.

Diagnostic, 3:00 P.M. *Chairman*, BERNARD H. NICHOLS, M.D.

17. Is the Present-day Nomenclature Relative to Diseases of the Vertebræ Pathologically Accurate? ARIAL W. GEORGE, M.D., Boston

    To be discussed by MAXWELL HARBIN, M.D., Cleveland, Ohio

18. Traumatic Lipo-nemarthrosis of the Knee. CARLTON B. PEIRCE, M.D., and D. C. EAGLESHAM, M.D., Montreal, Quebec, Canada

    To be discussed by MAXWELL HARBIN, M.D., Cleveland, Ohio

19. Roentgen Changes in the Cranial Vault Accompanying Diseases of Metabolic Disturbances. HUGH F. HARE, M.D., Boston

    To be discussed by JOHN D. CAMP, M.D., Rochester, Minn., and EUGENE FREEDMAN, M.D., Cleveland, Ohio

20. Ruptured Intervertebral Disc. A. T. BUNTZ, M.D., Cleveland, Ohio

    To be discussed by JOHN D. CAMP, M.D., Rochester, Minn.

21. Pseudofractures in Diseases Affecting Skeletal System. JOHN D. CAMP, M.D., Rochester, Minn.

    To be discussed by WALTER HILL, M.D., Cleveland, Ohio, and LOUIS A. MILKMAN, M.D., Scranton, Penna.

Tuesday Afternoon

Executive Session, 2:00 P.M.

Therapeutic, 3:00 P.M., *Chairman*, L. HENRY GARLAND, M.D., San Francisco

22. Irradiation Methods in Carcinoma of the Cervix Uteri, in Actual Practice. ROBERT R. NEWELL, M.D., San Francisco

23. Roentgen Irradiation of the Pelvis in Cancer of the Cervix Uteri. ROBERT S. STONE, M.D., and J. M. ROBINSON, M.D., San Francisco

24. Irradiation in Carcinoma of Cervix Uteri. SIMEON T. CANTRILL, M.D., and F. BUSCHKE, M.D., Seattle, Wash.

    The three foregoing to be discussed by AXEL N. ARNESON, M.D., St. Louis, Mo., and ROBERT R. NEWELL, M.D., San Francisco

25. The Induction of Multipolar Cell Division with X-rays and its Possible Significance. PAUL S. HENSHAW, Ph.D., Bethesda, Md.

    To be discussed by ROBERT S. STONE, M.D., San Francisco

26. Radiation Therapy of Brain Tumors. IRA I. KAPLAN, M.D., New York City

    To be discussed by MERRILL C. SOSMAN, M.D., Boston

Wednesday Morning, 10:30 A.M.

General, *Chairman*, BERNARD H. NICHOLS, M.D.

27. Ventriculography in the Diagnosis of Brain Tumors. MAX M. PEET, M.D., Ann Arbor, Mich.

    To be discussed by KARL KORNBLUM, M.D., Philadelphia, and JAMES GARDNER, M.D., Cleveland, Ohio

28. Pyelography and Excretory Urography in the Diagnosis and Treatment of Early Lesions of Renal Tuberculosis. GILBERT THOMAS, M.D., Minneapolis, Minn.

    To be discussed by KARL KORNBLUM, M.D., Philadelphia

29. Compression of the Heart. CLAUDE S. BECK, M.D., Cleveland, Ohio

    To be discussed by MERRILL C. SOSMAN, M.D., Boston, and A. C. ERNSTENE, M.D., Cleveland, Ohio

30. Diaphragmatic Hernia of the Stomach. DAVID S. BEILIN, M.D., Chicago

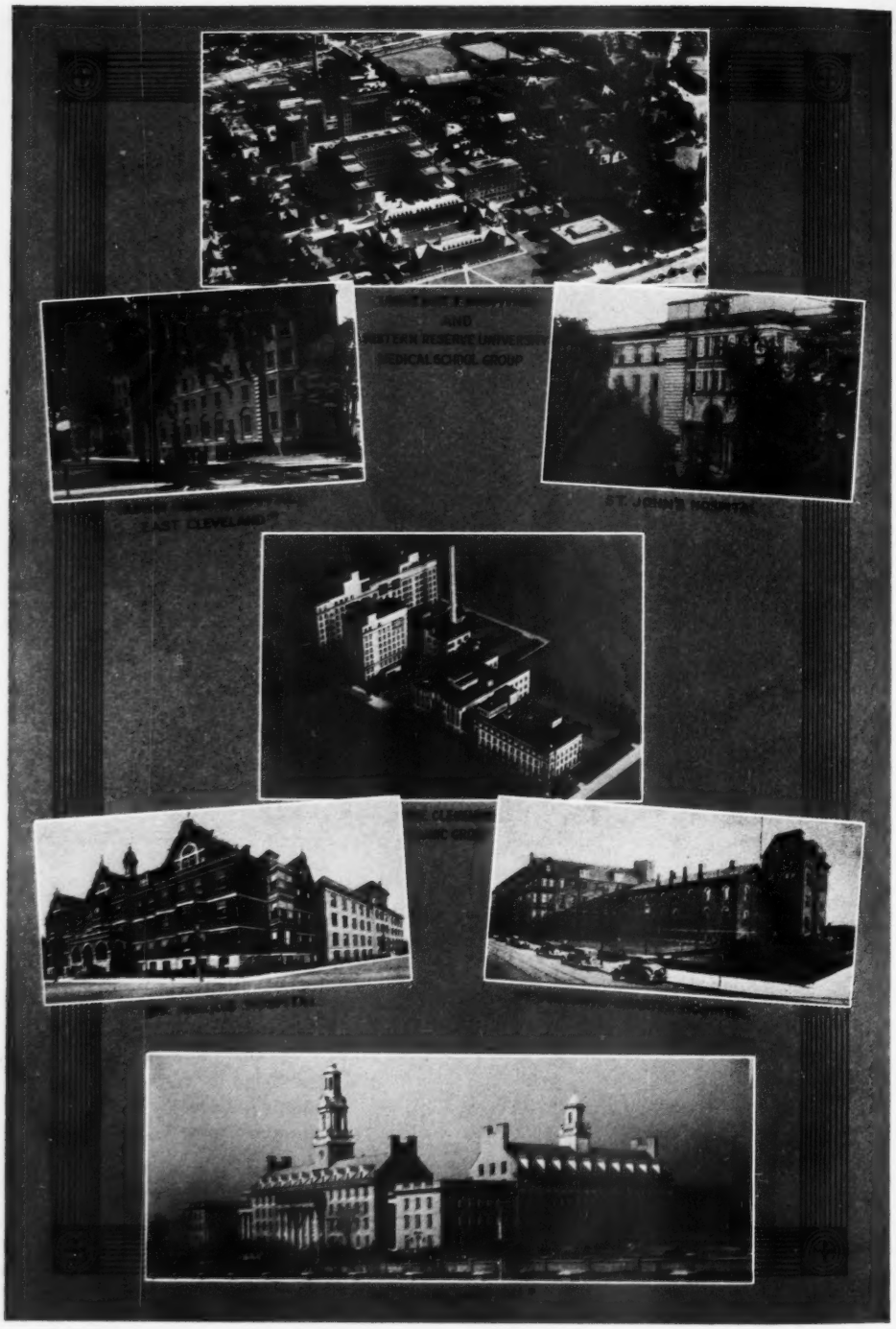
    To be discussed by GEORGE CRILE, JR., M.D., Cleveland, Ohio

Wednesday Afternoon, 2:00 P.M.

Diagnostic, *Chairman*, LEO G. RIGLER, M.D., Minneapolis, Minn.

31. Cholangiography, Fractional Method. WILLIAM S. ALTMAN, M.D., Boston

32. The Clinical and Roentgen Manifestations



*Courtesy Clifford Norton, Photographer.

Some of Cleveland's leading hospitals.

of Gastro-colic Fistula. MAX RITVO, M.D., Boston

33. The Study of the Intestinal Tract of Children and its Relation to the Adult. W. WALTER WASSON, M.D., Denver, Colo.

The three foregoing to be discussed by JAMES T. CASE, M.D., Chicago, EDWARD COLLINS, M.D., Cleveland, Ohio, and JOSEPH C. BELL, M.D., Louisville, Ky.

34. A Roentgenologic Consideration of the Normal Mucosa of the Duodenum. MAURICE FELDMAN, M.D., Baltimore, Md.

35. The Clinical Significance of Roentgenologic Findings of the Small Intestine. SIDNEY A. PORTIS, M.D., Chicago

The two foregoing to be discussed by JOSEPH C. BELL, M.D., Louisville, Ky., and JOHN F. RENSHAW, M.D., Cleveland, Ohio

Wednesday Afternoon, 2:00 P.M.

Therapeutic, Chairman, ROBERT R. NEWELL, M.D., San Francisco

36. The New High Voltage X-ray Standardization. LAURISTON S. TAYLOR, Ph.D., Washington, D. C.

37. Some Recent Contributions of Physics and Engineering Research to Radiology. BENEDICT CASSEN, Ph.D., East Pittsburgh, Penna.

38. The Evolution of Dosemeters in Roentgen-ray Therapy. OTTO GLASSER, Ph.D., Cleveland, Ohio

The three foregoing will not be discussed formally but questions may be asked.

39. Some Biophysical Effects of High Voltage Radiation on the Brains of Experimental Animals. KENNETH E. CORRIGAN, Ph.D., Detroit, Mich.

To be discussed by GEORGE C. LAURENCE, Ph.D., Ottawa, Ontario, Canada

40. The Absorption of Radio-phosphorus in Irradiated and Non-irradiated Mice. JOHN M. KENNEY, M.D., L. D. MARINELLI, M.A., and HELEN Q. WOODARD, Ph.D., New York City

41. Biological Applications of Microradiography. GEORGE L. CLARK, Ph.D., Urbana, Ill.

The two foregoing to be discussed by PAUL AEBERSOLD, M.D., Berkeley, Calif.

42. Further Studies on the Effects of Irradiation on Proliferation and Metabolic Processes of Normal and Malignant Mammalian Tissues. ANNA GOLDFEDER, M.D., New York City

(To be read by title.)

Thursday Morning, 10:30 A.M.

General, Chairman, BERNARD H. NICHOLS, M.D.

43. The Effect of Shock-proof Cables and Condensers on Two-valve, Half-wave Rectification. M. M. D. WILLIAMS, Ph.D., Rochester, Minn.

To be discussed by LAURISTON S. TAYLOR, Ph.D., Washington, D. C., and ROBERT R. NEWELL, M.D., San Francisco

44. Theoretical and Practical Considerations Concerning the Accuracy of Focal Spot Size Determination. LEWIS G. JACOBS, M.D., Winona, Minn.

To be discussed by OTTO GLASSER, Ph.D., Cleveland, Ohio

45. Distribution of Ionizing Energy in the Human Body Produced by Different Methods of Treatment. PAUL AEBERSOLD, Ph.D., Berkeley, Calif.

46. Depth Dose Measurements by Means of Goldfish. F. ELLINGER, M.D., and R. GROSS, M.D., New York City

The two foregoing to be discussed by OTTO GLASSER, Ph.D., Cleveland, Ohio, and PAUL S. HENSHAW, Ph.D., Bethesda, Md.

47. The Elimination of Thorotrast. K. WILHELM STENSTROM, Ph.D., Minneapolis, Minn.

To be discussed by ROBERT B. TAFT, M.D., Charleston, S. C.

Thursday Afternoon

Executive Session, 2:00 P.M.

Diagnostic, 3:00 P.M., *Chairman,* RABUN T. WILSON, M.D., Austin, Texas

48. Silicosis. GAGE CLEMENT, M.D., Duluth, Minn.

To be discussed by EDWIN C. ERNST, M.D., St. Louis, Mo.

49. Intrathoracic Neurofibromas. KARL KORNBLUM, M.D., and HOWARD BRADSHAW, M.D., Philadelphia

To be discussed by LEROY SANTE, M.D., St. Louis, Mo.

50. Roentgen Manifestations of Pulmonary Edema. LEO G. RIGLER, M.D., and

CURTIS B. NESSA, M.D., Minneapolis, Minn.

To be discussed by EDGAR P. MCNAMEE, M.D., Cleveland, Ohio

51. Congenital Cysts of the Lung. LAURENCE REYNOLDS, M.D., Detroit, Mich.

To be discussed by JOHN MCKAY, M.D., Cleveland, Ohio

Thursday Afternoon

Executive Session, 2:00 P.M.

Therapeutic, 3:00 P.M., *Chairman*, HOWARD P. DOUB, M.D., Detroit, Mich.

52. Irradiation in the Treatment of Carcinoma of the Rectum. HARRY H. BOWING, M.D., Rochester, Minn.

53. Combined Irradiation and Surgery in the Treatment of Cancer of the Pelvic Colon. HOWARD P. DOUB, M.D., J. P. PRATT, M.D., and H. C. JONES, M.D., Detroit, Mich.

The two foregoing to be discussed by L. HENRY GARLAND, M.D., San Francisco

54. The Use of Low Voltage Intravesical X-radiation in the Treatment of Carcinoma of the Bladder. LOWELL S. GOIN, M.D., Los Angeles, Calif.

To be discussed by JOHN T. MURPHY, M.D., Toledo, Ohio, and U. V. PORTMANN, M.D., Cleveland, Ohio

55. Further Experiences with Contact Therapy after the Method of Chaoul. EUGENE PENDERGRASS, M.D., Philadelphia

To be discussed by JOHN T. MURPHY, M.D., Toledo, Ohio, and U. V. PORTMANN, M.D., Cleveland, Ohio

56. Achondroplasia Foetalis. EDWARD L. JENKINSON, M.D., and R. E. KINZER, M.D., Chicago

To be discussed by PERRY MCCULLAGH, M.D., Cleveland, Ohio

Friday Morning, 10:30 A.M.

General, Chairman, BERNARD H. NICHOLS, M.D.

57. Adrenal Tumors and the Use of Air Insufflation for Diagnosis. GEORGE F. CAHILL, M.D., New York City

To be discussed by JAMES J. JOELSON, M.D., and PERRY MCCULLAGH, M.D., Cleveland, Ohio

58. Irradiation in Dermatology. ANTHONY C. CIPOLLARO, M.D., New York City

To be discussed by H. N. COLE, M.D. Cleveland, Ohio

59. The Treatment of Hemangiomas in Children. FRED M. HODGES, M.D., and R. A. BERGER, M.D., Richmond, Va.

60. The Roentgen Treatment of Myxomatous Cutaneous Cysts. HAROLD W. JACOX, M.D., Pittsburgh, Penna.

The two foregoing to be discussed by U. V. PORTMANN, M.D., Cleveland, Ohio

61. Roentgen Dose Fractionation for Variable Periodicities: Further Vagaries of the r Dose. W. H. MEYER, M.D., New York City

(To be read by title.)

Friday Afternoon, 2:00 P.M.

Diagnostic, Chairman, BERNARD H. NICHOLS, M.D., Cleveland, Ohio

62. The Nasal Accessory Sinuses. GEORGE W. GRIER, M.D., Pittsburgh, Penna.

To be discussed by JOHN D. OSMOND, M.D., Cleveland, Ohio

63. Measurement of Visual Acuity by Roentgen Ray. ROBERT R. NEWELL, M.D., San Francisco, Calif.

To be discussed by A. B. BRUNER, M.D., Cleveland, Ohio

64. Some Important Considerations of Soft-tissue Anatomy as Revealed by Radiography of Anatomical Cross-sections. JOHN R. CARTY, M.D., New York City

To be discussed by ROBERT J. ANDREW, M.D., Cleveland, Ohio

65. Roentgen Therapy of Tuberculous Cervical Lymphadenitis. HARRY HAUSER, M.D., Cleveland, Ohio

To be discussed by F. T. MOORE, M.D., Akron, Ohio

Friday Afternoon, 2:00 P.M.

Therapeutic, Chairman, RABUN T. WILSON, M.D., Austin, Texas

66. Twelve-year Review of X-ray Therapy of Gas Gangrene. JAMES F. KELLY, M.D., Omaha, Nebr.

To be discussed by ROBERT J. MAY, M.D., Cleveland, Ohio

67. Carcinoma of the Male Breast: A Review of 205 Cases. MAURICE D. SACHS, M.D., Portland, Oregon

To be discussed by HARRY FARMER, M.D., Cleveland, Ohio

68. The Treatment of Intra-oral Carcinoma.

WILLIAM E. HOWES, M.D., and L. BERNSTEIN, M.D., Brooklyn, New York

To be discussed by HARRY HAUSER, M.D., Cleveland, Ohio

69. Roentgen Irradiation of Calcareous Deposits about the Shoulder. LESTER W. BAIRD, M.D., Temple, Texas

To be discussed by HARRY HAUSER, M.D., Cleveland, Ohio

70. The Effect of Roentgen Therapy on Closure of the Epiphyses. DAVIS SPANGLER, M.D., Dallas, Texas

To be discussed by E. J. Ryan, M.D., Cleveland, Ohio

CONCERNING TRANSPORTATION TO THE CLEVELAND MEETING

Your local Transportation Committee has contacted all railroad, air, and bus lines operating into Cleveland. You will receive by mail information concerning rates, etc., to the Meeting from the different lines operating in your territory. Owing to the reduced railroad fares of recent years, the former fare and a third round trip certificate rates will not be in effect. Air lines offer 10 per cent reduction for round trip rate; however, if you should not use the return ticket, the price will be refunded.

The following air line rates from various cities to Cleveland are in effect:

From	One Way	Round Trip	Time
Atlanta	$ 43.00	$ 77.40	8 hr., 30 min.
Baltimore	19.10	34.38	3 hr., 10 min.
Boston	35.17	63.30	4 hr., 35 min.
Chicago	18.25	32.84	1 hr., 50 min.
Dallas	64.40	115.92	9 hr., 20 min.
Denver	69.72	125.48	7 hr., 35 min.
Des Moines	36.02	64.82	4 hr., 50 min.
Detroit	7.90	14.22	40 min.
Kansas City	39.75	71.54	5 hr., 25 min.
Los Angeles	123.25	221.84	14 hr., 25 min.
Madison	24.55	42.84	3 hr., 25 min.
Maine	80.25	144.50	12 hr., 15 min.
Milwaukee	22.40	39.49	2 hr., 40 min.
Minneapolis	34.75	60.34	4 hr., 25 min.
Montreal	44.95	80.91	5 hr., 40 min.
Nashville	30.50	54.90	6 hr., 20 min.
New York	26.70	48.06	3 hr., 5 min.
Omaha	42.75	76.94	5 hr., 40 min.
Philadelphia	23.20	41.76	2 hr., 35 min.
Pittsburgh	7.00	12.60	1 hr., 5 min.
Portland	117.25	192.84	13 hr., 55 min.
Rochester, Minn.	32.55	56.34	4 hr., 40 min.
St. Louis	30.50	54.90	5 hr., 5 min.
Salt Lake City	92.20	165.94	10 hr., 20 min.
San Francisco	123.25	221.84	14 hr., 55 min.
Seattle	117.25	192.84	15 hr., 5 min.
Washington, D. C.	19.10	34.38	2 hr., 5 min.

The Cleveland airport is about eight miles from downtown hotels. The taxi fare is 75 cents one way.

Members coming by automobile will find ample garage accommodations near all downtown hotels.

WALTER I. LEFEVRE, M.D.,
Chairman, Transportation Committee

A NOTE FROM THE ENTERTAINMENT COMMITTEE

The Entertainment Committee has sent the following information, which seems to promise "high jinks" for one evening, at least, during the Annual Meeting. It is called, believe it or not, "A Day in the Alps," and is set for Wednesday evening, Dec. 4, at 7 o'clock. Dinner, floor show, and dancing at the Alpine Village, 1614 Euclid Avenue, will be the order for that night. Tickets will be $1.75 per person, which includes the dinner but not the beverages. Guests are advised to order their tickets for this, as well as for the Banquet, as early as possible from the Committee.

COMMUNICATION

MICROFILM COPYING

The original articles referred to in this Journal are published in the periodicals received by the Army Medical Library, of Washington. Microfilm copying is being done by Medicofilm Service, a non-profit organization operating in the Army Medical Library. The charge is 30 cents for each complete article not exceeding 30 pages in length and 10 cents for each additional 10 pages or fraction thereof. A circular of information, containing a list of the more than 4,000 periodicals received by the Library, will be sent upon request to Medicofilm Service.

Orders and remittances should be sent to Medicofilm Service, Army Medical Library, 7th St. and Independence Ave., S.W., Washington, D. C.

BOOK REVIEWS

LEHRBUCH DER RÖNTGENOLOGISCHEN DIFFERENTIALDIAGNOSTIK DER ERKRANKUNGEN DER BRUSTORGANE (Textbook of Roentgenologic Differential Diagnosis of Diseases of the Chest). By WERNER TESCHENDORF, M.D., Chief Physician of the radiation institute, General Ortskrankenkasse, Köln. A volume

of 803 pages, with 891 illustrations. Published by Georg Thieme, Leipzig, 1939. Price: bound 71 R.M. (25 per cent discount allowed to foreign purchasers).

This text is really a companion volume to the author's text concerning diseases of the abdomen which was published about a year ago. The method of presentation, marginal notes, etc., are the same in each text. Part A, consisting of 486 pages concerning the differential diagnosis of roentgenograms of lung disease, constitutes the major part of the text and is divided into eleven chapters dealing with various aspects of the subject. The material is presented in a most interesting and informative manner that bespeaks the large experience of the author in both the practice and teaching of roentgenology. Part B, consisting of 190 pages, concerns the differential diagnosis of lesions of the heart. The roentgenologic material in this chapter is excellently co-ordinated with kymograms and electrocardiograms of representative cases. In Part C, 78 pages are devoted to a consideration of diseases of the esophagus. Part 4, consisting of 28 pages, deals with the significance of changes in the diaphragm.

All the chapters are profusely illustrated with roentgenograms and drawings that are excellently reproduced. A very useful text for those who read German.

PRINCIPLES OF ROENTGENOLOGICAL INTERPRETATION. By L. R. SANTE, M.D., Professor of Radiology, St. Louis University School of Medicine; Radiologist to St. Louis City Hospital and St. Mary's Hospital, St. Louis. A volume of 340 pages, with numerous illustrations. Published by Edwards Brothers, Inc., Ann Arbor, Michigan, 1940. Price: $5.50.

In the current edition of this well known book the number of pages of text remains the same as in the last edition; however, much of the material has been rewritten and rearranged. A noteworthy addition to the text are the 24 pages of roentgenograms, excellently reproduced on heavy enamelled paper. The arrangement of the chapters is the same as in previous editions. That section devoted to affections of the skeletal system occupies by far the greatest portion of the volume. Considerable attention is devoted to the treatment of fractures, a phase of the subject which seems unnecessarily emphasized for a fundamental roentgenologic text. The author's interest in diseases of the chest is reflected in the succinct but informative chapter dealing with that subject. Considering its importance in roentgenologic diagnosis the gastro-intestinal tract is somewhat slighted from the standpoint of space devoted to it. Duodenal ulcer, the most common roentgenologic lesion of the alimentary tract, is allotted hardly half a page of text and barely more consideration than that given to anatomy of the duodenum. The appendix and appendicitis rate more space than duodenal ulcer, but since this always has been a controversial subject among roentgenologists, it is perhaps deserved!

The author's partiality to intravenous cholecystography is reflected in the underscored statement, "Where no shadow of the gall bladder is obtained after oral administration of iodeikon, it cannot be accepted as definite evidence of pathology." Surely very few roentgenologists will let such a statement go unchallenged.

Chapter XXII, devoted to special examinations and procedures, is somewhat brief and could be expanded to advantage in the light of recent advances.

As a preliminary text for the instruction of students and practitioners of medicine in the essentials of roentgenologic diagnosis, this text will still remain a distinct favorite. Certainly it should serve to stimulate the serious neophytes of this interesting specialty.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S. R. BEATTY, M.D., of Oshkosh, Wisc.
JAMES J. CLARK, M.D., of Atlanta, Ga.
PERCY J. DELANO, M.D., of Chicago
SYDNEY J. HAWLEY, M.D., of Danville, Penna.
ANTONIO MAYORAL, M.D., of New Orleans, La.
JOHN M. MILES, M.D., of Lafayette, La.
ERNST A. POHLE, M.D., PH.D., of Madison, Wisc.
SIMON POLLACK, M.D., of St. Louis, Mo.
ERNST A. SCHMIDT, M.D., of Denver, Colo.
CHARLES G. SUTHERLAND, M.D., of Rochester, Minn.

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

THE INTESTINES

Intussusception of the Sigmoid. Harry F. Bayard. Minnesota Med., **22,** 456–458, July, 1939.

Bayard points out that intussusception occurs at several different levels in the gastro-intestinal tract but is chiefly thought of in differential diagnosis of an acute abdominal condition in children under one year old. C. W. Mayo, writing on chronic intussusception, in 1934, stated that the sigmoid was the most frequent offender.

In adult life, colonic intussusception is frequently predicated upon the basis of a tumor within the lumen of the colon. A long mesentery and inadequacy of the supporting ligaments of the pelvic floor, together with the pressure of a sigmoidal tumor, are mechanical factors making adult intussusception possible. A colonic contraction wave gripping a tumor within the lumen pushes the tumor area ahead and the invagination process is started.

A polyp which has a fairly long pedicle is more prone to initiate invagination than a sessile tumor, and, likewise, the size or bulk of the tumor influences the possibility of intussusception.

Symptoms are variable. Pain in the pelvis and rectum, if transient, may suggest that a reduction of the invagination has in some way been effected. Bleeding is uncommon unless the intussusception has been present for a long time.

Treatment includes the preliminary giving of an enema, which will, in some cases, bring about reduction—this may be done with barium under fluoroscopic control. Sometimes putting the patient on a proctology examination table and introducing air will bring about reduction.

Operative procedures are described, and a case cited.

PERCY J. DELANO, M.D.

The Roentgen Anatomy of the Small Intestine. George W. Chamberlin. Jour. Am. Med. Assn., **113,** 1537–1541, Oct. 21, 1939.

Anatomically, the small intestine is a convoluted tube which begins in the upper part of the abdomen just distal to the pylorus and ends at the ileocecal valve. The length of the small intestine is variable. At autopsy it may measure from 5 to 7 meters. Intubation by measured length of tubing has indicated a length of from 2.5 to 3 meters from the pylorus to the cecum. It is generally assumed that the upper three-fifths of the mesenteric small intestine is jejunum and the lower two-fifths is composed of ileum. Six primary coils of small intestine have been described; the first coil is the duodenum, while the remaining five comprise the ileojejunum, or mesenteric small intestine. Many variations in the appearance of these coils have occurred.

In the normal controls studied, the head of the meal reaches the cecum in from one and a half to three hours. Roentgenologically, one can distinguish duodenum, jejunum, and ileum, although the line of demarcation is not well defined. The duodenum, which begins just distal to the cap at the first circular fold of mucosa, is short, wide, and relatively fixed in position. It forms an incomplete loop around the head of the pancreas and may be divided into a superior, a descending, a transverse, and an ascending portion. The cap and superior duodenum are usually retentive, but in the remaining portions of the duodenum peristaltic rushes and to-and-fro motion may be seen. In the duodenum the stream is of the intermittent type. Beyond the suspensory ligament of Treitz the speed of forward motion decreases. The barium stream tends to be continuous with an occasional peristaltic rush. Through the jejunum and ileum the progress of the meal is mostly a gradual creeping forward of the contents, becoming slower as it approaches the cecum. In some instances a complete arrest of the meal may occur in the ileum. If the patient is then allowed to eat, the contents will proceed into the colon without further delay.

The mucosal pattern of the small intestine shows many variations which seem to be specific for a given set of physical conditions. Such a pattern is derived from the primary circular folds of Kerkring and from the secondary induced folds which may occur in the mucous membrane. The primary folds of Kerkring are largest in the duodenum and jejunum, become smaller and less frequent in the lower jejunum and ileum, and may be poorly developed or absent in the terminal ileum. They are not obliterated by distention and they persist in postmortem specimens. The folds adapt themselves to the muscular contractions of the intestinal wall and also to the consistency and form of the meal. At roentgenologic examination the pattern of a given segment depends on its anatomic character and also on its physiologic activity at the time of the examination.

The various patterns are shown in a series of illustrations.

CHARLES G. SUTHERLAND, M.D.

Regional Ileitis. Alberto Anzilotti. Radiol. med., **26,** 685–719, August, 1939.

Dr. Anzilotti reports two cases of terminal ileitis which he has observed, and discusses a third which has not been treated surgically. The author goes extensively into the pathology, etiology, and differential roentgenologic diagnosis. He believes that there are two distinct forms: one frankly chronic; the other initiated by acute symptoms with a tendency toward chronicity. The radiologic picture is variable and conforms to the stage during which the affection is seen. The most common finding is a cord-like appearance of a section of the terminal ileum, in which the mucosa has been almost or totally destroyed. Ordinarily, the cecum or colon is spared.

ANTONIO MAYORAL, M.D.

Regional Ileitis. John W. Holloway. Ohio St. Med. Jour., **35,** 1059–1061, October, 1939.

In reviewing 10 cases of regional ileitis, the author

refers to early reports of such lesions and to the recent clear-cut analysis of this type of lesion by Crohn, with whom he agrees, and who considers the condition to progress in four main stages, as follows:

1. Acute phase—fairly sudden onset, characterized grossly by sharply demarcated edematous segment of inflamed thickened ileum which stops abruptly at the ileocecal valve. The mesenteric nodes are usually involved. This clinically simulates appendicitis and is usually operated on as such.

2. Subacute phase found in those cases in which inflammatory changes in the bowel progress to ulceration. The bowel wall at this stage is sponge-rubber-like in consistency and quite friable. Clinically the presence of diarrhea may become manifest.

3. The fibrosing or stenotic type is progression to cicatrization and canalization of the involved segment by the non-specific granulomatous tissue. Beside signs of possible partial small intestinal obstruction, the development of anemia and emaciation and often of a palpable right lower quadrant mass is quite characteristic.

4. Fistula formation, either external or internal, characterizes the other group of chronic cases.

The acute and subacute forms cannot be diagnosed by x-ray study, according to the author, who feels that gastro-intestinal studies are contra-indicated in the acute cases. The characteristic narrowing deformity "string sign" or fistulous tracts may be demonstrated in x-ray studies of the chronic cases.

The treatment of choice in the chronic cases is a first stage short-circuiting operation followed by a resection of the involved loops. Recurrence is reported in from 10 to 15 per cent of cases.

SIMON POLLACK, M.D.

Roentgenologic Manifestations of Non-neoplastic Lesions of the Small Intestine. Harry M. Weber. Jour. Am. Med. Assn., **113,** 1541–1546, Oct. 21, 1939.

The roentgenoscopic examination is the cardinal roentgenologic maneuver. A preliminary survey of the abdominal field, to insure that there is no evidence of intestinal obstruction, is made. The roentgenoscopic examination of the stomach and duodenum is made, then as much as possible of the opaque suspension is expressed from the stomach into the duodenum and jejunum. Usually only a certain quantity can be expressed at a single roentgenoscopic session lasting from five to ten minutes. The patient is then allowed to relax, lying on the right side, for ten to fifteen minutes, when another roentgenoscopic examination is made. Periods of rest followed by roentgenoscopic examinations are repeated at intervals of fifteen minutes until the stomach has delivered all but an insignificant quantity of the suspension of the opaque medium into the intestine. At about this time a lull in the more vigorous intestinal movements sets in. A simple palatable breakfast, preferably chosen by the patient according to individual taste and custom, is a pleasant and practical way to stimulate the intestinal motility and distend the coils in the desired way.

Immediately after breakfast, periodic roentgenoscopic examinations are resumed until such time as the opaque material has made its way to the lowermost portion of the ileum and cecum. The time required for the contrast material to pass from the stomach to the cecum varies considerably in apparently normal persons. Forty-five minutes of elapsed time is not considered to be abnormally fast; four or five hours, not abnormally slow.

Roentgenographic examinations, with or without the use of the Potter-Bucky diaphragm, are made at the examiner's discretion, to clarify doubtful or suggestive areas of abnormality and to supply a permanent record of the roentgenologic manifestations. The most satisfactory way of examining the lowermost portion of the ileum is by filling it in retrograde direction through the ileocecal orifice at the conclusion of the examination of the colon, by using a contrast enema. Examination is made before and after the patient is permitted to empty the opaque fluid from the colon.

Pathologically, chronic enteritis, using this term in its broadest possible sense, would include chronic intestinal lesions of tuberculosis, syphilis, bacillary dysentery, and lymphopathia venereum as well as lesions caused by pathogenic fungi and parasites, and lesions for which a specific etiologic agent has not as yet been determined.

The roentgenologic examiner will often find it necessary to confine his diagnosis to a description of the general morphologic character of the process and its distribution in the intestinal tract.

CHARLES G. SUTHERLAND, M.D.

Clinical Aspects of Chronic Disorders of the Small Intestine. Everett D. Kiefer. Jour. Am. Med. Assn., **113,** 1546–1551, Oct. 21, 1939.

This study was restricted to the rôle of the small intestine in the etiology of chronic abdominal disorders and to the consideration that must be given it in the diagnosis of chronic digestive complaints.

There are few symptoms which are highly diagnostic of disease of the small intestine. Obstructive lesions may cause vague prodromal symptoms, such as a sense of fullness or cramplike pain after meals, but the almost completely fluid nature of the content of the small intestine makes for an "all or none" type of obstruction. There is no obstruction until suddenly there is complete obstruction, with an acute onset of symptoms that are either persistent or intermittent, depending on the mechanical status of the point involved.

Abdominal distress immediately after meals, flatulence, and diarrhea are suggestive of hypermotility. Grossly inadequate absorption results in large, foul, fatty stools, failing nutrition, calcium imbalance, and avitaminosis. Anemia is not uncommon in disorders of the small intestine and is the result of inadequate absorption of iron and other blood-forming substance or, more commonly, the result of chronic blood loss. Gross hemorrhage also occurs and the passage of a large amount of red blood by rectum points to a possible lesion in the jejunum or ileum.

The general physical signs of disease of the small intestine are malnutrition, anemia, and signs of vitamin deficiency. The other important abdominal finding may be a mass.

By far the most important single laboratory procedure is the x-ray examination of the gastro-intestinal tract. Positive diagnosis is often made possible by roentgenograms taken during an attack.

CHARLES G. SUTHERLAND, M.D.

THE LUNGS

A Case of Cysticercus of the Lungs. A. Hahn. Radiol. Glasnik, **3,** 86–89, June, 1939.

A case of cysticercus involvement of the hilar glands is described, the diagnosis being verified by biopsy. In addition to the lungs, cysticercus incrustations could be seen in the musculature of the lower extremities and of the shoulder girdle.

ERNST A. SCHMIDT, M.D.

The Value of Hemoptysis as a Symptom for the Radiologist. Rémy-Roux. Bull. et mém. Soc. de radiol. méd. de France, **27,** 103, 104, February, 1939.

Hemoptysis is not always a symptom of pulmonary tuberculosis or cardiac disease and every radiologist knows of many cases which have been carefully observed without developing pulmonary lesions. It is justifiable to tell a patient who has had hemoptysis, but who has negative radiologic, clinical, and laboratory findings, that he has little to fear.

There may be many causes of hemoptysis, including endocrine upsets (*e.g.*, hemoptysis catamenial) or vasomotor and hematologic syndromes. Such cases, however, should have repeated roentgenologic studies of the lungs.

S. R. BEATTY, M.D.

Two Cases of Gigantic Cavities of the Lung Simulating Empyema. E. Costantini. Riv. di pat. e clin. d. tuberc., **13,** 193–203, March 31, 1939.

Costantini reports two cases of total destruction of the left lung (gigantic cavities) diagnosed clinically and roentgenologically as empyema. Both patients died and the correct diagnosis was made at the autopsy. The roentgenograms illustrating the article reveal complete absence of lung tissue in the left thorax, with some fluid at the bases, suggesting a hydropneumothorax.

In his discussion, the writer states that these gigantic cavities are found with greater frequency in the left lung, for the following reasons: lesions of the right lung become bilateral more often than those of the left lung, the patient dying before there is time for the formation of a gigantic cavity; the right lung is more voluminous; in the right lung the greater number of interlobar septi afford greater obstacle to the spread of the infection. The author further points out the difficulty in making the differential diagnosis during life, and, in conclusion, makes the following statement: "For the occurrence of a gigantic lung cavity the following factors must be present: (*a*) tuberculous infection limited to one lung; (*b*) the presence of all of the pleura, and (*c*) stoppage of the drainage."

ANTONIO MAYORAL, M.D.

PEPTIC ULCER

Perforation of an Ulcer Left in the Duodenal Stump Following Gastrectomy: Report of Two Cases. Edward Etzel. Ann. paulist. de med. e cir., **38,** 111–117, August, 1939.

Perforation of an ulcer left in the duodenal stump, following a partial gastrectomy, is reported. The author believes such cases should be given great publicity, since these operations are done often and are thought to be free from danger.

The writer reports two cases, in both of which the rupture was into the free peritoneal cavity. In one it occurred on the fifth post-operative day. The ulcer had a very shallow base and this was suspected as the cause. In the other case, death followed operation in 19 hours. In the latter case, an attempt had been made to excise the ulcer before the partial gastrectomy was undertaken, and the perforation is suspected to have been caused by traumatism done during the attempt.

ANTONIO MAYORAL, M.D.

Duodenal Ulcer in the Young. Giuseppe Bignami. Radiol. med., **26,** 394–409, May, 1939.

The author, basing his opinion on statistical data, believes that gastric and duodenal peptic ulcers in the young are not so rare. The author emphasizes the fact that he refers to the type of ulcers so commonly found in adults.

The operative findings at Ulmea Hospital and the roentgenologic findings of Michaelsson, both placing the frequency as 3.5 per cent, are not, Bignami believes, true figures. He cites his own cases—186—of which nine, or 5 per cent, belong to the juvenile group. If it is remembered that roentgenologic examinations of the gastro-intestinal tract are not as frequently made in children as in adults, even the above figures are low.

When examining children, the roentgenologist should be on guard, and not be led away from the actual pathology by the vagueness of the symptomatology and by the lack of precision in the patient's description.

In the young patient, because of the lack of indirect signs, such as hypermotility or hypersecretion, which are so helpful in the adult cases in stimulating the physician's curiosity and exciting him to a more thorough search, the diagnosis is rendered still more difficult. The age of predilection for the development of these ulcers, the author believes, is the end of the first decade, in which opinion he seems to be in complete accord with Theile and Finkelstein. The history is of extreme importance in these patients as quite often one or both parents have a history of ulcers, or at least a history suggestive of having had ulcers. As in adults, the niche is the pathognomonic sign of ulcer.

ANTONIO MAYORAL, M.D.

RADIATION EFFECTS

Contribution to the Problem of the Point of Attack of Rays on Living Matter. B. Bellucci. Strahlentherapie, **65,** 547, 1939.

The author discusses some of the theories regarding the mode of action of rays of short wave length on cells. One schematic diagram is shown, illustrating his own conception of the various steps in the reaction to irradiation beginning with ionization and finally leading to the various biologic effects.

ERNST A. POHLE, M.D., Ph.D.

Intensity of Radiation and Selective Action. J. van Roojen. British Jour. Radiol., **12,** 547–553, September, 1939.

It is now generally agreed that the action of radiation is independent of the wave length. If there is a difference between the action of gamma and x-rays, it must be due to some other factor. The only other possible variation is intensity. Experiments have indicated that variation in effect might be due to variation in the periodicity of sensitivity of cells or to a process of recovery taking place while the destructive process is going on. The shape of dose-intensity curves indicates that the latter takes place. With high intensities the dose is independent of the intensity. With low intensity the dose must be increased. These facts are confirmed by clinical experience.

Equations are derived showing these effects mathematically, disregarding recovery effects, making use of several reasonable assumptions.

The concept of a specific sensitivity of cells so that they can be arranged in an order of susceptibility does not hold for low intensities. Selectivity of action appears when the intensity is so low that the factor of recovery comes in. It is possible that we may be able to improve results by further decreasing the intensity but we do not yet know if this is so, nor how much reduction is best. Lowering of the intensity cannot be pushed beyond a certain point if the desired result is to be obtained. The destruction must be greater than the normal rate of growth. Reducing the intensity may allow us to continue the radiation until the tumor has vanished, thus relieving us of the uncertainty about the total dose required.

Geometrical homogeneity of distribution is important. Successive application of beams from various ports is not equivalent to continuous action in a homogeneous field.

SYDNEY J. HAWLEY, M.D.

RADIUM

Treatment of Cancer of the Breast by Electrocoagulation and Radium. Robert Julien. Bull. et mém. Soc. de radiol. méd. de France, **27,** 114, 115, February, 1939.

Radical surgical procedures in breast cancer violate the principles of cellular sterility which are the basis of the surgery of cancer. The operations are, moreover, mutilating and disabling and, in favorable cases, less radical procedures are equally effective.

The author precedes surgery by transcutaneous electrocoagulation of the tumor masses. Surgery is conservative and the wounds are closed without trauma.

Radium is applied externally to avoid tissue destruction. The author uses tubes of 2 mm. Pt equivalent screened with aluminum and rubber. Six or seven 10-mg. tubes in a disk of 6 cm. diameter can be left on for from 48 to 60 hours per field. Sponge rubber pads are interposed between the plaques and the skin to allow ventilation and reduce skin reaction. The glandular areas are also treated by roentgen therapy.

With this procedure there are the additional advantages of avoidance of shock and hemorrhage.

S. R. BEATTY, M.D.

A Radium Implant Reconstructor. H. M. Parker and W. J. Meredith. British Jour. Radiol., **12,** 499–503, August, 1939.

The accurate measurement of the dose delivered by interstitial needles by means of a micro-ionization chamber is almost impossible. The authors have described a very ingenious apparatus for reconstructing the position of the needles. X-ray films of the patient are made with the needles in place from two angles, preferably right-angles. Tracings of the films are made. These are placed in an apparatus so that light can be thrown through both of them at the same time, while they are oriented in space as they were when taken. The intersection of the shadows from the two tracings locates the needles accurately in space. Dummy needles are moved about until the shadow intersection locates them. They are then held in place by sticking the end in plasticine. Thus the needles are located in space with relation to each other as they were in the body. The dummy needles are then replaced by real ones and measurements of the dosage may be made. The apparatus can be so built that it will take films made at any angle or for stereoscopic films.

SYDNEY J. HAWLEY, M.D.

ROENTGEN RAYS, BURNS AND INJURIES

The X-ray Burn. (Monthly editorial prepared by the Medical Advisory Committee.) Minnesota Med., **22,** 488, 489, July, 1939.

In meeting large numbers of men attending medical conventions, one is struck by the number who show x-ray burns of the hands. A caution is thrown out to those who take large numbers of films and who do much fluoroscopy. A case in point is cited: a patient seriously injured through the pelvis and spine had six x-ray films taken by his local physician when it was decided to take him to a consultant. Here, several more exposures were made; he was then hospitalized, where additional films were made. In all, some 20 exposures were made of his pelvis and back within a period of 48 hours. Then, within the week, more films were taken.

It is pointed out that if the patient in this case had been of a susceptible type, so far as skin sensitivity was concerned, a radiodermatitis might easily have been possible as a result of the diagnostic endeavors.

PERCY J. DELANO, M.D.

Traumatic Radiation Combination Injuries. V. Lundt. Strahlentherapie, **66,** 162–180, 1939.

The author defines the term "traumatic radiation combination injury" as a late injury following irradiation, the appearance of which is caused by an additional factor, as, for instance, mechanical insult. He describes briefly four cases which fall under this heading and lists 41 additional cases collected from the literature.

ERNST A. POHLE, M.D., Ph.D.

Contribution to the Question of Roentgen Sarcoma. U. Cocchi. Strahlentherapie, **65,** 173, 1939.

The author reviewed the literature regarding the occurrence of malignant neoplasms following x-ray or radium therapy and found that they were observed only in the skin. Similar changes within the body have so far not been demonstrated. Cocchi reports a case of malignant struma treated by roentgen rays and examined at postmortem 15 months later. Although a sarcoma was found then, the question as to the causal rôle of the irradiation is answered in the negative.

ERNST A. POHLE, M.D., Ph.D.

A Skin Eruption Caused by X-ray Therapy on Endocrine Glands. Sylvia Bray. British Jour. Radiol., **12,** 312–315, May, 1939.

A number of cases of skin eruption have been noted since 1930, following treatment of the ovaries, thyroid, and pituitary by radiation. Abstracts of the histories of seven such cases, observed since 1933, are given.

The rash is of a red papular type, intensely itchy, occurring on the thighs, trunk, and upper arms. It may be localized or generalized. It appears between three and one-half to eight weeks after starting therapy. It responds readily to applications of calamine lotion plus menthol. None of the patients developed the rash after subsequent courses of irradiation.

SYDNEY J. HAWLEY, M.D.

ROENTGEN RAYS, PROTECTION

Protection in Fluoroscopy. C. A. Stevenson. Texas St. Jour. Med., **35,** 12–15, May, 1939.

For self-protection in fluoroscopy, the author recommends the lowest possible kilovoltage and milliamperage; an aluminum filter of from 0.5 to 1 mm.; short exposures; small exposure fields; a speedy examination; the use of the protection afforded by the tissue being examined, and the avoidance, as much as possible, of placing the hand in the visible fluoroscopic field.

Fluoroscopic reduction of fractures and fluoroscopic foreign-body work are condemned. Chest fluoroscopy should offer no problem if ordinary care is taken. Gastro-intestinal fluoroscopy has been investigated thoroughly, as regards problems of protection.

Although no change in the use of lead rubber protective devices has been advocated, it appears probable that the average radiologist of to-day would be safe in relying upon a proper technic and the above principles of protection, as far as gastro-intestinal work is concerned.

As a substitute for fluoroscopy in fracture work, the author suggests a hot developer technic by means of which a radiograph can be taken and viewed within three minutes, the film not being permanent.

JOHN M. MILES, M.D.

Measurements of the Protection in the Radiotherapeutic Department of the Institute de Cancer de la Faculté de Médicine de Paris. J. Belot and L. Dauvilliers. Bull. et mém. Soc. de radiol. méd. de France, **27,** 78–82, February, 1939.

The authors describe the methods used to protect patients and personnel against high voltage contacts in the department of radiotherapy.

Protection from irradiation is provided by suitable thickness of concrete and lead. The dosage in no place exceeds 0.0006 r per hour and in most locations is 0.0003 r per hour or less, as compared to the international limit of 0.025 r per hour.

S. R. BEATTY, M.D.

ROENTGEN-RAY THERAPY

The Intensity Distribution of Roentgen Rays in "Rotating" Irradiation. M. Nakaidzumi and T. Miyakawa. Strahlentherapie, **66,** 583, 1939.

The authors measured the intensity distribution of roentgen rays in a rotating beeswax cylinder of 28 cm. diameter and 20 cm. height, using a Sievert condenser dosimeter. The distance from target to diaphragm was 30 cm., from target to phantom surface 40 cm., and from target to rotating axis 50 cm. Under these conditions the depth dose at the rotating axis, which is 10 cm. below the surface, is approximately two to three times as large as the dose on the surface. The percentage depth dose of roentgen rays depends primarily on the width of the beam of radiation; the smaller the width the larger the depth dose. The quality of radiation had hardly any influence on the percentage depth dose for a range of half value layers from 0.58 mm. to 0.89 mm. Cu equivalent to a potential range of from 120 to 160 kv. They also describe a method of maintaining the tumor in the correct position during irradiation.

ERNST A. POHLE, M.D., Ph.D.

The Calculation of the Dose in "Rotating" Irradiation. R. du Mesnil de Rochemont. Strahlentherapie, **66,** 593, 1939.

An analysis of measurements on a phantom regarding the depth dose in "rotating" irradiation shows that scattered radiation escaping the beam increases considerably the dose on the surface. This effect is most

pronounced for small areas. This, of course, tends to decrease the depth dose percentage. Since, however, the fields used in practice are larger than those used in the experimental measurements (2 and 4 cm. width) it is to be expected that this disadvantage is considerably less when treating patients. The author describes a technic which, in his opinion, does not require fluoroscopic screen control during irradiation to ascertain the correct position of the tumor.

ERNST A. POHLE, M.D., Ph.D.

Beam Direction in X-ray Therapy. J. L. Dobbie. British Jour. Radiol., **12,** 121–128, February, 1939.

Because of injury to the surrounding tissue, it is wise to use as small a beam as possible. With small beams, accurate position is essential. To accomplish this, the author advises making wax molds of the part in which a depression is cast so that the cone or applicator can be put in perfect position each time. The method of making the molds is described in detail. Accuracy is secured by x-ray examination with the mold in place, using a diagnostic tube in exactly the same manner as the treatment tube. This method may be used for parallel or converging beams and is particularly useful in parts of the body such as the neck.

For some situations, such as the head and jaws, a method is described for making a cast of celluloid-like material. Accurate localization is obtained by putting nipples in the case which fit into holes on the end of the applicator.

For the accurate positioning of the beam in cross-firing lesions in the trunk, a protractor which fits over the patient is described.

SYDNEY J. HAWLEY, M.D.

THE SKULL

Hyperostosis Calvarii Interna: Its Clinical Significance. B. N. Tager, E. K. Shelton, and W. C. Matzen. California and West. Med., **51,** 384–388, December, 1939.

The authors have reviewed 492 consecutive cases in which roentgenograms of the skull were made in a lateral projection. Of this number 66 positive cases, or an incidence of 13.4 per cent, were found in which hyperostosis calvarii interna was demonstrated. These cases were thoroughly studied from the neurologic, metabolic, and endocrine viewpoints. Found preponderantly in the female, the condition appears to be an incidental observation in a variety of unrelated clinical states. Analysis of body build, symptoms, and metabolic data failed to disclose any consistent abnormalities. The etiology and the possible clinical significance of this condition remain obscure.

JAMES J. CLARK, M.D.

Asymmetry of the Skull in Relation to Subdural Collections of Fluid. James Hardman. British Jour. Radiol., **12,** 455–461, August, 1939.

In a growing patient, any space-taking lesion, if present for a sufficient length of time, will cause an outward bulging of the overlying skull. The most common causes are subdural hematoma and subdural hydroma. Three cases are reported. One patient, aged 12 years, had had an asymmetry of the skull since the age of five. This patient probably had a cyst into which hemorrhage had occurred following an injury. The second patient, eight years of age, showed a deformity of the skull nine weeks after an injury, due to a subdural hematoma. The third case reported, that of a five-year-old patient, had a swelling on the left side of the forehead, due to a cyst.

SYDNEY J. HAWLEY, M.D.

THE SPINE

Recurring Atlo-axial Dislocation with Repeated Involvement of the Cord and Recovery. Gordon R. Kamman. Jour. Am. Med. Assn., **112,** 2018–2020, May 20, 1939.

Between the atlas and the axis (first and second cervical vertebræ) there are three diarthroses. Two of these are lateral and have to do with articular processes, and the third is mesial. This mesial diarthrosis is between the posterior aspect of the anterior arch of the atlas (first cervical vertebra) and the anterior surface of the odontoid process of the axis (second cervical vertebra). Alignment between the atlas and axis is maintained by the anterior and posterior atlo-axoid ligaments and by the transverse ligaments of the atlas. If either the transverse ligament of the atlas or the odontoid process of the axis (dens) gives way, there is an anterior dislocation of the atlas on the axis. The pyramidal decussation lying just behind the odontoid process may be compressed with resulting paralysis of the extremities.

Spontaneous dislocation is considered to be due to hyperemic decalcification of the atlas with loosening of the transverse ligament. This results from infections in the nasopharynx or elsewhere in the vicinity of the base of the skull. It occurs most frequently in children. There is a latent period of from seven to ten days between the time of infection and the dislocation. The part of the arch of the atlas nearest the infection is calcified.

Traumatic atlo-axial dislocation is usually due to a fracture of the odontoid process of the axis. This deprives the transverse ligament of the atlas of its anchorage and permits the atlas to slide anteriorly on the axis. The condition results from injuries to the neck, manipulative adjustments, convulsive seizures, and birth injuries. The symptoms of traumatic dislocation may be immediate or delayed. There may be a latent period of days, or even months or years. At the time of injury the local symptoms may be absent or minimal and these may disappear rapidly. After the latent period, neurologic signs and symptoms develop. These are frequently obscure and progress slowly. The reasons given for the appearance of symptoms after a prolonged latent period are redislocation, progressive dislocation, excessive callous formation, pachymeningitis and pressure myelitis, irritation of the cord

due to abnormal motility, late developing osteomyelitis, and adhesive arachnoiditis with calcification (arachnoiditis ossificans).

The author was able to find only one case in the American literature similar to the one he reports.

CHARLES G. SUTHERLAND, M.D.

Fractures of the Spine Complicating Metrazol Therapy. Basil T. Bennett, Jr., and Charles P. Fitzpatrick. Jour. Am. Med. Assn., **112,** 2240–2244, June 3, 1939.

Convulsive therapy was conceived on the basis of reports as to the infrequency of the occurrence of both epilepsy and schizophrenia in the same individual and the fact that patients known to have schizophrenia had greatly improved or had recovered when spontaneous epileptic seizures developed.

With the rapidly increasing popularity of this type of therapy, it would seem reasonable to assume that as many as 4,000 patients have received some form of convulsive therapy.

Seventeen patients at Butler Hospital have received metrazol therapy. The number of convulsions produced in each case varied from two to fifteen, with a total of 117 convulsions for the entire group. Eight of the patients treated complained at some time of pain in the back. Roentgenographic examinations revealed compressed fractures of the dorsal vertebræ in all patients who had complained of backache. The authors suggest the possibility of a herniated or ruptured intervertebral disc as another complication.

The problem of combating this detrimental feature of an otherwise beneficial therapy is being studied with orthopedic and roentgenologic consultants.

CHARLES G. SUTHERLAND, M.D.

THE STOMACH

Physiology of the Stomach. L. Gleize-Rambal. Bull. et mém. Soc. de radiol. méd. de France, **27,** 92–95, February, 1939.

There are a number of explanations for the mechanism of gastric emptying. The author advances his opinion that a very important part of this mechanism is the pumping action, on the vertical portion of the stomach, of the diaphragm as it descends. A considerable force is transmitted through the column of air which usually lies above the fluid level in the stomach.

He has observed that deep inspiration—cough or sneeze—has been sufficient to pass food through a spastic pylorus, and that usually the opening of the pylorus is concomitant with an advancing peristaltic wave and an inspiratory excursion of the diaphragm.

Is it possible that the air column is an important if not indispensable factor in gastric emptying, acting as does the piston in a pump? Are aerocoly and aerogastry, for example, reactions to the necessity for an additional force to propel a bolus through a point of obstruction?

S. R. BEATTY, M.D.

Pneumatosis Cystoides of the Stomach and Jejunum. R. Baumann-Schenker. Acta Radiol., **20,** 365–372 August, 1939.

Roentgen Diagnosis of Pneumatosis Cystoides Intestinorum Hominis. Stig Berglund. Acta Radiol., **20,** 401–405, August, 1939.

These two articles, appearing simultaneously from different countries (Switzerland and Sweden), stress the fact that this rare disease, cystic pneumatosis of the gastro-intestinal tract, may be detected roentgenologically by the visualization of the vesical structure of the wall of the viscus. However, the two authors disagree with regard to the etiologic factors involved. While Baumann-Schenker attributes the disease to the effect of adhesions following a chronic ileus of long standing and declines any bacillary origin, Berglund considers infection the essential cause. Both cases were confirmed by biopsy. A second laparotomy, after the biopsy, in Berglund's case, showed the disappearance of all signs of pneumatosis in the previously affected portion of the ileum.

ERNST A. SCHMIDT, M.D.

Gastroscopic and Roentgenologic Findings in Membranous Gastritis. Knud Lundbæk. Acta Radiol., **20,** 394–400, August, 1939.

The case of a 58-year-old man is described in whom the roentgenogram suggested cancer of the stomach. Two years later an ulcer of the lesser curvature was diagnosed roentgenologically, and gastroscopic examination revealed the presence of a membranous gastritis which probably had produced the appearance of cancer in the first x-ray examination.

ERNST A. SCHMIDT, M.D.

A Case of Small Gastric Carcinoma (*image encastrée*). R. A. Gutmann, G. Beaugeard, and Rognon. Bull. et mém. Soc. de radiol. méd. de France, **27,** 75–78, February, 1939.

The authors present the details of a case of early gastric carcinoma to illustrate their contention that fluoroscopy alone is insufficient to rule out very early infiltrations of the gastric wall. A typical early picture, usually discovered only on the films, is that of "cancer encastrée." This consists of a flat-topped, filling-in defect, with straight, rigid, lateral borders. This image may be hidden partially or completely by the other parts of the adjacent stomach walls which are less infiltrated. The picture is typical and warrants a preoperative diagnosis of localized gastric carcinoma.

In this case, as in many others with similar findings, the diagnosis was confirmed histologically.

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